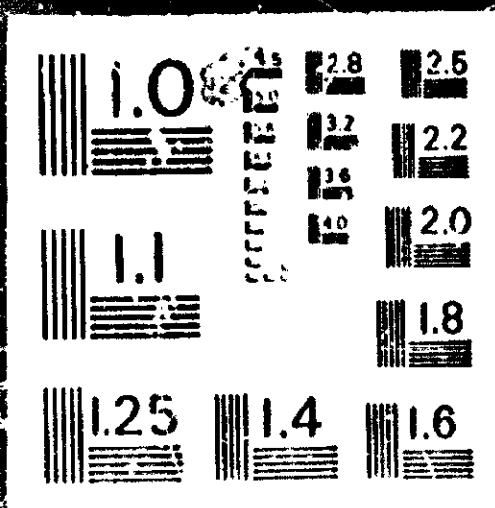


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**U.S. DEPARTMENT OF COMMERCE  
National Technical Information Service**

**PB-299 532**

**Safety Effectiveness Evaluation of the National  
Highway Traffic Safety Administration's Rulemaking  
Process. Volume 1. Case History of Federal Motor  
Vehicle Safety Standard 121: Air Brake Systems**

**(U.S.) National Transportation Safety Board, Washington, DC**

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# **NATIONAL TRANSPORTATION SAFETY BOARD**

WASHINGTON, D.C. 20594

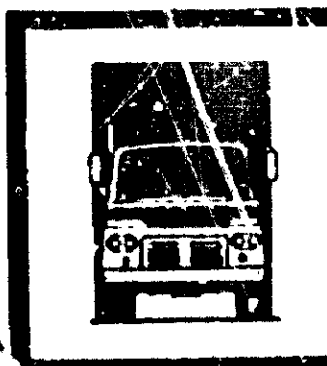
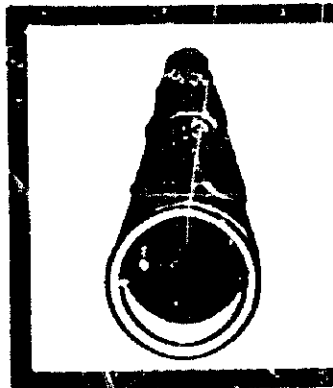
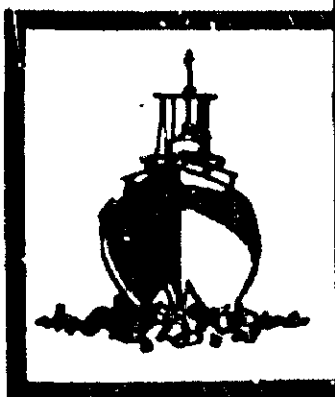
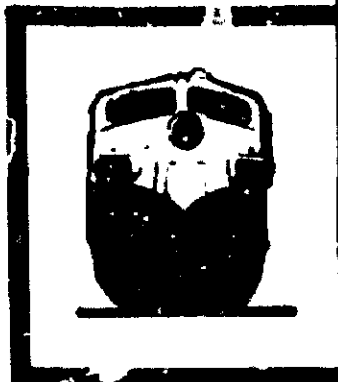
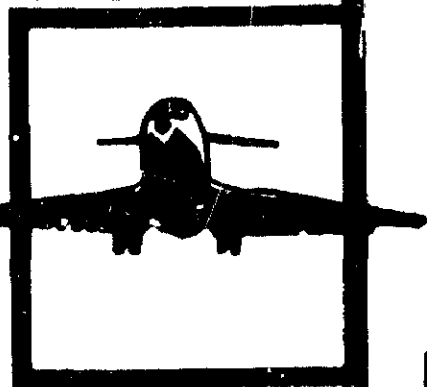
## **SAFETY EFFECTIVENESS EVALUATION OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION'S RULEMAKING PROCESS**

### **VOLUME 1 -- CASE HISTORY OF FEDERAL MOTOR VEHICLE SAFETY STANDARD 121: AIR BRAKE SYSTEMS**

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16. Abstract <p>This report presents a history of the development of Federal Motor Vehicle Safety Standard (FMVSS) 121: Air Brake Systems. That standard specified air brake system performance requirements for trucks, buses, and trailers. FMVSS 121 was issued by the National Highway Traffic Safety Administration (NHTSA) in February 1971. FMVSS 121 has been a very controversial standard with much of the controversy surrounding the use of antilock devices (computerized modules) to meet the requirements of the standard. These antilock devices were designed to sense the impending skidding of a wheel during braking. The devices would then modulate the pressure to the brake to prevent the skidding. This controversy led to litigation and final ruling by the Ninth U.S. Circuit Court of Appeals in 1978.</p> <p>This report is a presentation of the facts of how the standard was developed and implemented. It does not analyze the issues nor does it include an evaluation of the technical aspects of the standard. The purpose of this report is to provide a factual account of the rulemaking activities of this standard. This case history will be used as a part of a subsequent safety effectiveness evaluation of the NHTSA rulemaking process which will be published in 1979.</p>			
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NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C. 20594

SAFETY EFFECTIVENESS EVALUATION OF THE  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION'S  
RULEMAKING PROCESS  
VOL. I: CASE HISTORY OF FEDERAL MOTOR VEHICLE  
SAFETY STANDARD 121: AIR BRAKE SYSTEMS

Adopted: August 2, 1979

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Introduction

The Independent Safety Board Act of 1974 directs the Safety Board to "evaluate, assess the effectiveness, and publish the findings of the Board with respect to the transportation safety consciousness and efficacy in preventing accidents of other government agencies . . . ." This mandate is primarily fulfilled by conducting "safety effectiveness evaluations" of selected programs being administered by the various agencies.

The Safety Board currently is conducting a safety effectiveness evaluation of the rulemaking process of the National Highway Traffic Safety Administration (NHTSA). The evaluation, which will be completed in 1979 will include case histories on this standard, the passive restraint standard, and current rulemaking of the NHTSA. The overall evaluation will respond to congressional directives that the Safety Board conduct studies of certain areas of the NHTSA rulemaking, including "an evaluation of the truck braking standards . . . ." <sup>1/</sup>

This report presents one of the case histories that the Safety Board will analyze in the safety effectiveness evaluation of the NHTSA Rulemaking. This case history sets forth the facts and the sequence of events associated with the promulgation by the NHTSA of Federal Motor Vehicle Safety Standard (FMVSS) 121, the standard which specifies air brake system performance requirements for trucks, buses, and trailers.

The case history was developed by the Safety Board through review of the NHTSA public dockets related to the standard's development, through review of the technical literature, and through interviews with Federal safety officials, representatives of vehicle and component manufacturers, and other persons involved in the development of the standard.

The draft of this report was made available to the NHTSA for comment. Where applicable, those comments have been included in this version of the report. This report is based on data and information received as of May 25, 1979.

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<sup>1/</sup> U.S. House of Representatives, Report No. 95-1169, Part I, p.3.

### Background

Federal Motor Vehicle Safety Standard (FMVSS) 121: Air Brake Systems, was issued under the authority of the National Traffic and Motor Vehicle Safety Act of 1966 (Safety Act of 1966). 2/ That Act directed that motor vehicle safety standards be established to regulate the safety performance of new vehicles.

FMVSS 121 was issued by the National Highway Safety Bureau (NHSB), which later was to become the National Highway Traffic Safety Administration (NHTSA). In 1967, NHSB was an element of the Federal Highway Administration (FHWA). FHWA was created as part of the Department of Transportation (DOT) when the department was formed in 1967. The NHSB had been the National Traffic Safety Agency of the Department of Commerce, which was assigned responsibility for the promulgation of motor vehicle safety standards under the Safety Act of 1966. In 1971, when NHSB was removed from FHWA and reorganized as a separate operating administration within DOT, it was redesignated the National Highway Traffic Safety Administration (NHTSA).

FMVSS 121 was the first Federal motor vehicle safety regulation which had a major impact on the vehicle manufacturers in the trucking industry. Under the Safety Act of 1966, NHSB (and eventually the NHTSA) were responsible for the development, implementation, and monitoring of safety standards that set performance criteria to which vehicle manufacturers were required to certify the compliance of their vehicles. At the same time, the Federal Highway Administration's Bureau of Motor Carrier Safety (BMCS) retained its responsibility, which predated the Safety Act of 1966, for regulating the safe operation of commercial motor carriers. BMCS had regulations in effect for truck braking performance for many years before FMVSS 121 was issued. With the implementation of FMVSS 121, the large commercial vehicle manufacturers were required to comply with two braking performance regulations promulgated by two separate Federal agencies--the NHTSA regulation for the performance of new vehicles (FMVSS 121), and the BMCS regulation for the performance of vehicles in service in interstate and foreign commerce.

NHSB issued FMVSS 121 as a Notice of Proposed Rule Making (NPRM) in June 1970, and as a final rule in February 1971. According to its declaration of purpose, the standard was issued "to insure safe braking performance under normal and emergency conditions" for newly-manufactured trucks, buses, and trailers equipped with air brake systems.

The standard specified certain requirements for braking system performance, including stopping distances, brake retardation forces, in-lane control, and a "no wheel-lockup" requirement. The latter was to become the most controversial provision as the standard progressed through 8 years of rulemaking modifications.

A wheel "locks" when it is overbraked. Overbraking can occur when the vehicle's brakes are applied on a slippery road surface or when the vehicle is empty. The skidding tire (or locked wheel) is not desirable for two important reasons: The vehicle's stopping distance is increased; and the directional stability

2/ P.L. 89-563, September 9, 1966; 15 U.S.C. 1381 et. seq.

of the vehicle can be adversely affected. In emergency stopping situations, maximum vehicle deceleration and directional stability is available if the tire rotation is restricted to incipient skid (i.e., just prior to wheel-lockup). Because the axle loads on any given vehicle vary and the tire-to-road frictional coefficient is constantly changing, it is impossible to predetermine the exact point of incipient skid. The "no wheel-lockup" provision of the standard required that the vehicle braking system did not go beyond incipient skidding except momentarily, at vehicle speeds higher than 10 mph.

The controversy over the "no wheel-lockup" provision led to litigation and final ruling by the U.S. Court of Appeals for the Ninth Circuit in 1978. The major thrust of the litigation was that the provision required the use of antilock devices, which the court ruled were not proven to be reliable or shown to improve safety. Typically, antilock devices are electronic computer modules that sense the impending skidding of a wheel during braking and automatically modulate air pressure to the brake chamber to keep the wheel rolling. While these devices have been known by a variety of terms--including "skid control," "antiskid," "adaptive braking," and others--in this report, except when direct quotations are presented, the term "antilock" is used to describe such devices.

While the "no wheel-lockup" provision was the most controversial provision of FMVSS 121, it was by no means the only source of concern over the standard. FMVSS 121 requirements affected virtually every aspect of braking system performance, and in some cases its performance requirements could not be met without major modification of other vehicle components as well as the braking system. Many of the standard's requirements were protested. In addition, certain aspects of the rulemaking process itself were questioned in many of the thousands of comments and petitions that were submitted to the NHTSA's FMVSS 121 rulemaking docket.

The following pages present a detailed account of the relatively long and complicated history of FMVSS 121 rulemaking. They describe a variety of events including: The issuance of Advance Notices of Proposed Rule Making (ANPRM's), Notices of Proposed Rule Making (NPRM's), and final rules; the development of sophisticated braking systems; research efforts and technical papers; comments objecting to the standard and petitions for reconsideration of the NHTSA's rulemaking actions; amendments to the standard; postponements of its implementation; agency reorganizations; agency consideration of indefinite postponement; litigation and rulings by the court of appeals and by the U.S. Supreme Court; and issuance of a new ANPRM nearly 12 years after the original ANPRM was issued.

Few persons outside the agency which conducted the rulemaking and the industry affected by it are entirely familiar with all of the facts and circumstances surrounding the development of FMVSS 121. This case history provides a chronology of the major events and activities associated with the detailed rulemaking case of FMVSS 121.

#### State-of-the-Art of Air-Braked Vehicles Before 1970

The state-of-the-art of large commercial vehicle braking in the years before 1970 is shown by the review of technical papers such as the work of the Society of Automotive Engineers (SAE). These papers provide technical insight as to the

capabilities of the heavy duty vehicle industry to meet specific performance criteria. For example, SAE Special Paper 299, <sup>3/</sup> under a discussion of brake effectiveness requirements, defined an ideal situation:

The best stopping distance would be obtained if the vehicle had a fixed center of gravity location and axle weight distribution and operated only on road surfaces giving a fixed tire-to-road coefficient of friction. The brake system could then be constructed so that all wheels changed from a rolling to a sliding or skidding condition at the same rate of deceleration. In this way the available tire-to-road adhesion would then be fully utilized. The brake system has to be compromised from this ideal situation, however, as the vehicle must also operate with different loads and on roadways with various surface conditions.

In light of this need to design brake systems to cover less-than-ideal situations, SAE in 1967 published "Truck and Bus Brake System Performance Requirements (SAE J992)," which set forth requirements for such items as: preburnish check, burnish, effectiveness, fade and recovery. The tests were considered to represent a desired state-of-the-art and not necessarily that attainable by all manufacturers. In fact some of the vehicles used in test runs to develop the requirement failed to meet the proposed criteria. The stated purpose of the SAE performance requirements explains their relationship to the state of the art:

The basic objective of SAE standards is to provide industry and the general public with uniform data based on sound, established engineering procedures. These standards and recommended practices are not drafted as regulations or statutes. However, government agencies have referenced SAE reports, in statutes and regulations, because of their reflection of good engineering practice.<sup>4/</sup>

Therefore, the recommended performance requirements of SAE J992 set forth braking system criteria which were reflective of "good" system performance. The test data used to develop the requirements verified "the fact that minimum brake performance specified in J992 for trucks and buses is quite stringent." <sup>5/</sup> For example, in 1967 SAE J992 specified that a heavy vehicle (over 10,000 pounds) be able to stop from 20 mph in 35 feet and attain a minimum deceleration of 12 ft/sec<sup>2</sup> from 50 mph. BMCS regulations at that time required in-service combination vehicles to stop in 50 feet from 20 mph.

While not directly comparable with the SAE criteria, testing done for NHTSB showed that there was wide variation in the braking capabilities of heavy vehicles. Stopping distances for loaded tractor-trailer combinations from 60 mph ranged between 222 and 376 feet in NHTSB tests in 1970. <sup>6/</sup> Corresponding maximum decelerations were 20.0 and 14.0 ft/sec<sup>2</sup> respectively. Vehicle combinations

<sup>3/</sup> Service Brake System Performance Requirements for Automotive Vehicles, (SP-299), Society of Automotive Engineers, Inc., November 1967.

<sup>4/</sup> Ibid.

<sup>5/</sup> Ibid.

<sup>6/</sup> R. W. Murphy et. al., "Bus, Truck, Fractor-Trailer Braking System Performance," Contract No. FH-11-7290, Highway Safety Research Institute of the University of Michigan, March 1971.

selected by the NHTSB to reflect the current state-of-the-art in braking performance were used in these tests.

The technology of braking systems had progressed slowly before 1970. Typical product development consisted of research design, prototype construction, laboratory testing, test track trials, limited field testing of prototypes, field testing of production models, sale as an optional item, and then finally offering as standard equipment. Typically the lead time to accomplish this cycle for a comprehensive product change was 5 years.

The truck and bus industry was characterized as a fairly conservative market in which new products would be accepted only after extensive testing for reliability. Some of the braking-related systems which were in varying stages of the product development cycle in 1970 included: split air and hydraulic brake systems for heavy trucks, modulated spring brakes, disc brake systems, retarders, timing kits, automatic slack adjusters, 7/ load proportioning or sensing devices, 8/ mechanical antilock devices, and electronic antilock devices. 9/

The large commercial vehicle industry was extremely diversified and the selection of vehicle components was made on a customer-by-customer basis. Therefore, the marketability of a particular system was highly dependent upon its use by that customer. If a new system would not directly benefit the customer's particular type of operation, it would not be well-received. This customization directly affected the industry's development of new products. Customer demand had to be demonstrated before new products were introduced on a large scale.

The Hytrol<sup>10/</sup> antilock system was modified for the heavy trucking industry in 1959. Its primary commercial motor vehicle customers were the tank truck carriers because it met their need for reducing brake torque while operating with empty tanks. Chevron Corporation first began using a mechanical computer antilock system in 1959. Gulf Oil Corporation was using the Hytrol system after it had been acquired by Kelsey-Hayes in 1966. Between 1966 and 1970 Kelsey-Hayes installed their system on 2,000 vehicle axles. However, when interviewed by the Safety Board, maintenance managers from the petroleum carriers expressed mixed opinions on the effectiveness and reliability of these earlier antilock devices.

#### Advance Notices of Proposed Rule Making

On October 11, 1967, the NHTSB issued an Advance Notice of Proposed Rule Making (ANPRM) for Federal Motor Vehicle Safety Standards. This notice solicited comments on 47 separate aspects of motor vehicle safety ranging from crash avoidance to nonoperational safety. One of the 47 items dealt with braking

7/ Automatic slack adjusters are devices designed to readjust the brake shoes after each application thereby keeping them in adjustment.

8/ Load proportioning devices modulate brake chamber application at each foundation brake in proportion to the weight in an effort to provide optimum brake torque.

9/ Early antilock wheel sensors were inertia flywheel devices which electrically signaled an air chamber mounted solenoid valve when wheel lockup was about to occur.

10/ Developed by the Hydro-Aire Division of Crane Company in 1948 and first used on aircraft.

systems for multipurpose passenger vehicles, trucks, buses, and trailers. It established Docket 1-2 for receipt of comments. The ANPRM stated,

Standard No. 105, issued January 31, 1967 (32 F.R. 2410) as amended June 30, 1967 (32 F.R. 10072), specifies requirements for service brake, emergency brake, and parking brake systems for passenger cars. The Administrator is considering extending the applicability of the Standard to specify braking requirements for multipurpose passenger vehicles, trucks, buses, and trailers.

Although comments were due on February 5, 1968, the NHTSB accepted comments until April 1970. When it was closed, Docket 1-2 contained 100 submissions.

For the most part, brake component manufacturers recommended following the requirements of SAE J992 as a starting point for brake system performance. The Midland-Ross Corporation submitted comments on the emergency and parking brake systems and also indicated that load-sensing valves <sup>11/</sup> could reduce stopping distances by as much as 50 percent on certain vehicles under specified conditions. On February 12, 1970, representatives of NHTSB met with Berg Manufacturing Co. to discuss Berg's "Syncon" system, which accelerated brake actuation on trailer brake systems.

Vehicle manufacturers endorsed the submission of the Automobile Manufacturers Association, Inc. (AMA). The AMA recommended that NHTSB incorporate provisions of FMVSS 105, BMCS regulations, SAE J992, and the National Education Association's "Minimum Standards for School Buses." An effective date of January 1, 1970, was suggested. Brake proportioning methods were not recommended because AMA believed that "no such method has yet been sufficiently proven under vehicle use conditions to be appropriate as a mandatory method." The Truck Trailer Manufacturers Association (TTMA) recommended continuation of the current BMCS regulations. White Trucks suggested that brake proportioning devices not be specified until sufficient testing had been conducted to determine their reliability and performance; that no requirements should be made for use of brakes on all wheels (especially front axles); and that the proposed standard apply to single-unit vehicles and not to combination vehicles. Chrysler Corporation recommended that SAE J992 be used without change.

The American Trucking Associations, Inc. (ATA) believed that any effort to apply passenger car braking requirements to heavy combination vehicles would fail. They suggested that careful consideration be given to the current BMCS regulations as a basis for rulemaking. They also suggested that an informal working conference be held between all interested parties to work out realistic details for a standard. Concerning load proportioning devices, ATA claimed that most of them were still in the experimental stages. They also stated that "...the ultimate need is to eliminate locking of the wheels of an axle in brake application. Consideration may well be given to anti-locking brake devices." ATA cautioned that mandatory requirements based on advanced technology not yet on the market would end up being counterproductive.

<sup>11/</sup> Refers to brake proportioning devices described in footnote 8.

While comments were still being received in Docket 1-2, NHTSB issued an additional ANPRM concerning heavy vehicle performance. On January 17, 1969, Docket 69-1 was established to receive comments. Docket 69-1, "Stability and Control of Coupled Vehicles; Trucks, Truck Trailers, Semitrailers, and Trailers," dealt with many issues of vehicle stability and in particular brakes and devices to prevent jackknifing. Comments were requested on the factors which contribute to vehicle stability, and on test procedures that could be used to measure performance. Comments were requested by May 15, 1969.

Most comments in the response to Docket 69-1 suggested that definitive data on the subjects covered by the ANPRM were not available and that a comprehensive research program should be implemented under the sponsorship of NHTSB or DOT.

One of the documents submitted in Docket 69-1 was a report of testing done in Utica, Michigan, in 1967. <sup>12/</sup> The tests, sponsored by the AMA and TTMA, covered the braking, stability, and structural integrity of longer combination vehicles. The tests covered various combinations of tractor-trailers on both dry and wet pavements. The tests evaluated the vehicles under two conditions-- as received and modified. As received was defined as the condition the vehicle was in when received from the manufacturer. Modified referred to changes in the air distribution lines to improve brake timing and the addition of load-sensing brake-proportioning valves. <sup>13/</sup> The results of the tests showed that the modified braking systems did improve stopping distances.

One criterion for each test run was that the vehicle combination make a controlled stop, which basically meant the vehicle had to go from the test speed to a complete stop while remaining within a 12-foot-wide lane. The stopping distances obtained by the test vehicles varied by the loading of the combination vehicles and the modifications to the braking system. For the most part, the average stopping distances for the "as received" vehicles were close to 200 feet from 50 mph on dry pavement. The "modified" vehicles averaged a stopping distance of 190 feet from 50 mph on dry pavement. The report indicated that varying weights of trailers in a combination vehicle had a significant bearing on the directional stability of the combination vehicle as did the modifications to brake timing. An evaluation of the load-sensing brake-proportioning valves was not made because the necessary test runs to isolate the effect of these devices were not made.

The docket submissions from AMA and TTMA suggested that: There were devices on the market designed to control jackknifing but that they were relatively untested; the Utica, Michigan, test results indicated that combination vehicle control and stability was a complex issue; and that more research was necessary to develop objective performance criteria and recommended that NHTSB join with the industry to perform the research. AMA stated that:

<sup>12/</sup> "Braking, Stability and Structural Integrity of Longer Combinations: A Technical Report on Tests Conducted at Utica, Michigan, May 8-July 27, 1967" AMA-TTMA Longer Combinations Braking Task Force, October 1, 1968.

<sup>13/</sup> Brake timing and brake proportioning refer to changes in valving and air lines to optimize braking effectiveness and directional control.

The state of the art in vehicle handling has simply not reached a level that would permit the development of either performance criteria or test procedures. Comprehensive research covering the full range of handling test procedures. . . . is a vital prerequisite to any standard. Until the interaction of the many factors which affect the stability and control of coupled vehicles can be objectively measured by performance tasks, any proposals for regulation at this time would lack sufficient foundation and therefore be premature.

Kelsey-Hayes indicated that they were marketing a successful electromechanical antilock system for trailers, and that individual control devices for each brake should be given consideration by NHTSB. Jacobs Manufacturing Company indicated that they produced an automatic brake modulation system which controlled wheel lockup.

The American Petroleum Institute believed that the state of the art of antijackknifing devices had not progressed to the point where regulatory mandates were warranted. They suggested that the normal marketplace incentives be continued to allow manufacturers to develop their products. ATA suggested that the Administrator consider increased vehicle width as a method of improving vehicle stability. ATA also stressed that an experienced driver was a critical factor in maintaining vehicle control and stability: "If a driver lacks basic training, no amount of advanced technology seems to do much good." ATA stated that wheel lockup is the root of the problem in jackknifing but that there were no current devices which could be depended on to solve that problem.

Several research papers in the docket indicated that antilock devices were effective in preventing jackknifing accidents for combination vehicles.

#### Early Development of the Standard

On February 3, 1970, the Director of the Motor Vehicle Safety Performance Service (MVSPS—the rulemaking arm of NHTSB) sent a memorandum to the Director of the National Highway Safety Bureau specifying a 10-element program of proposed truck standards. Among these 10 elements was "Air Brake System Performance" which was to become FMVSS 121. The memorandum contained the following rationale:

Attached is a chart "MVSPS Projected Rule Making Activities Relating to Specific Truck Size and Weight Proposals." This delineates the various issuance dates for all of the above items, as well as the proposed effective dates. To attain this schedule not only does the highest priority have to be assigned to these items, but the time lost in coordination has to be severely attenuated. In addition, the completion dates of the various phases of the rule making activities are predicated upon limiting the preparation of the rule making document, the preamble and standard only, in order to utilize the considerable time now devoted to the backup papers, such as Engineering Position Paper and Executive Summary. Further, these rule making actions will be applicable to large trucks and trailers only. Buses and small trucks will be handled on a lower priority basis.

The specific program for the air brake system performance standard also called for the establishment of an in-house task force composed of six persons: the Deputy Director of MVSPS, two safety standard engineers, representatives of Research and Development and BMCS, and an attorney. The stated objective of the task force was to:

Prepare a draft of a Notice of Proposed Rule Making on this subject, as complete as possible, considering the lack of substantive data currently available to the Bureau. Concurrently, with this action, qualified members of user and manufacturing groups will be approached to serve in an advisory capacity.

Upon completion of the draft NPRM, it will be circulated to those advisors for review. A meeting will be held with the task force and the advisors to arrive at the final NPRM. It is anticipated that the present contract with the University of Michigan, FH-11-729D, will provide substantiation for values arrived at in the NPRM.

The "advisory" group, selected by the NHSB Task Force, consisted of: two major truck manufacturers—Chrysler Corporation and White Motor Corporation; two brake component manufacturers—Rockwell Corporation and Berg Manufacturing and Sales Company; a trailer manufacturer and a trade group—Fruhauf Corporation and TTMA; and a vehicle operator's group—ATA.

On March 9, 1970, 34 days after the memorandum was signed, NHSB presented the "advisory" group with working drafts of two FMVSS 121 NPRM's. The first applied to trucks and buses, the second to trailers. Another NHSB memorandum 14/ recorded that during that meeting the "advisory" group was told that "the truck, bus and trailer air brake portion of Docket 1-2 was now being expedited. . . ."

The "advisory" group, according to the record, reported at the meeting that they:

did not think it was possible to stop trucks in minimum distances without locking at least one wheel unless anti-wheel locking devices [were] used and these, they said, won't be ready by 7-1-71; they thought that staying in the 12-foot lane should be sufficient. NHSB answered that locking of wheels had a significant effect upon the stopping distance and NHSB would be willing to increase the stopping distance required in order to specify unlocked wheels. NHSB also said they wanted to encourage antiwheel locking devices.

In addition, the participants questioned several other provisions of the working draft of the standard. Most of the comments recorded were concerned with the specific values used and the "advisory" group promised to submit recommendations for changes to the values. "NHSB indicated that. . . they were open to suggestions as to what performance values should be," the NHSB memorandum stated.

14/ NHSB Memorandum for the Record, dated April 3, 1970, Docket Item No. 01-02-ANPRM-098.

The reference to the March 9, 1970, meeting is the only indication that was found in the docket of any industry-government interaction during the drafting of the first two NPRM's for FMVSS 121. However, members of the task force did visit some antilock component manufacturers and were present at industry demonstrations of antilock systems. NHTSB was told that these systems would be available for production within the next year and a half. One task force member recalled, the "advisory" group met approximately five times to discuss details of the working papers. The "advisory" group was used to evaluate industry reaction to specific NHTSB proposals and was not used to draft any of the performance requirements of the standard.

While there are noticeable differences in format between the working drafts and the NPRM's which were issued on June 18, 1970, the basic areas of braking systems covered are identical in both documents. Many of the performance criteria changed between March 9, 1970, and June 18, 1970; most of the changes relaxed the proposed requirements. No other documents relating to the specific development of the criteria were found in the public docket.

The majority of the work of the task force was done by one safety standards engineer. He was also responsible for four other proposed standards. The other members of the task force participated to varying degrees, but, for the most part only provided coordination between different elements of DOT.

Those members of the task force interviewed by the Safety Board indicated that they were under the impression that the NHTSB was concerned about possible increases in the size and weight limitations on trucks. <sup>15/</sup> They indicated that there was considerable pressure to develop standards to cover trucks and that a very limited time schedule was established. All 10 proposed standards were intended to be implemented as final rules by June 1971. The task force members believed that the standards should be implemented even if the size and weight increases were not enacted. They stated that this pressure for quick results precluded research projects or accident data analysis to develop the drafts for FMVSS 121. The one safety standards engineer developed the specific performance criteria on an intuitive basis. The specific criteria were developed as "starting points" with further relaxations in mind. The strategy used up to the point of the final rule was that more stringent criteria should be established in the working drafts and NPRM's. The NHTSB could request comments on the criteria and then have justification in the docket for relaxations of the criteria. An example of this concept is the selection of the stopping distance from 60 mph. The working draft NPRM specified 196 feet and the published NPRM specified 216 feet. The distance specified in the first version of the final rule (February 19, 1971,) was 245 feet.

<sup>15/</sup> A more detailed account of the truck size and weight issue is contained in the Safety Board file for this report.

### Notices of Proposed Rule Making

On June 18, 1970, the NHTSB issued two Notices of Proposed Rule Making (NPRM's) concerning air brake systems. The first NPRM dealt with trucks and buses, the second with trailers. Both NPRM's proposed to establish "requirements for air service brake and parking brake systems to insure safe braking performance under normal and emergency conditions." The requirements were applicable to all vehicles equipped with air brakes. The proposed effective date for both NPRM's was January 1, 1972.

The NPRM's specified performance criteria for several aspects of vehicle braking. Compliance with the criteria was to be established by subjecting vehicles to road tests and/or brake lining dynamometer tests. The NPRM's established four primary measures of braking system performance:

- o Specific stopping distances for various speeds on wet and dry surfaces, using the service and emergency brake systems;
- o the requirement that the vehicle stop without locking any wheel more than momentarily;
- o the requirement that the vehicle remain within a 12-foot-wide lane during the stops; and
- o specific timing requirements for brake application and release.

The NPRM's specified brake balance requirements for combination vehicles by specifying a relationship between brake chamber air pressure and brake retardation force. The NPRM for trailers did not specify stopping distances, but established brake retardation requirements along with the same "no wheel-lockup" and 12-foot-wide lane requirements detailed for trucks and buses.

Other significant provisions in the NPRM's included requirements for a split service brake system, air reservoir specifications, condensate drain valves, towing vehicle protection valves, pressure gauge and warning signal, antilock warning signal for trucks and buses (if equipped with an antilock system), and parking brake performance requirements.

The NPRM's also specified a deadline for receipt of comments of September 21, 1970. The two NPRM's were published on June 25 and 26, 1970, which allowed a period of 87 days for preparation of comments. TTMA and the Friction Materials Standards Institute, Inc. both petitioned for an extension of the comment period. These petitions were denied because the NHTSB staff believed that the period for comment was dictated by the pressure to implement the standard as soon as possible and therefore no extensions could be allowed.

The majority of the comments received on the NPRM's were similar and contained the following points: (1) The scope of the NPRM's was complex and the time allowed for comment restricted the amount of testing which could be done to support comments; (2) the effective date of January 1, 1972, was impractical in light of the "no wheel-lockup" requirement of the NPRM's; and (3) the stopping distances were too severe and, therefore, the lead time for implementation should be extended.

The comments from brake component manufacturers were varied. For example, the Midland-Ross Corporation recommended the deletion of the momentary lockup restriction of the standard and suggested the use of load-sensing brake proportioning devices in place of antilock devices. The Friction Materials Standards Institute, Inc., stated that the stopping distances required unrealistically high decelerations which were not possible with the current brake systems. Wagner Electric Corporation stated that the requirements would cause severe problems when pre- and poststandard vehicles were intermixed and that reliability and availability of electromechanical brake control systems were not established. Eaton, Yale and Towne, Inc. believed that the stopping distance requirements could be met with brake system improvements. They believed that effective dates of October 1, 1973, for antilock on drive axles and October 1, 1974, for all axles would be more realistic.

Kelsey-Hayes stated that production models of antilock systems were commercially available; 1 year would be needed to build up to full manufacturing rates; that full compatibility for each trailer with all tractor braking systems should be required; and that their testing indicated that existing production drum brakes could not meet the stopping distance or dynamometer requirements.

The comments from vehicle manufacturers were similar in nature, varying only in the degree of relaxation requested. All of the vehicle manufacturers questioned the effective date, stating that such comprehensive changes to brake systems would require 3 to 5 years of lead time. Many vehicle manufacturers requested a two-phase standard with requirements similar to SAE J992 as the first phase and improved braking at some later date as the second phase. Most of the comments indicated that antilock devices were unproven and would require many years of actual field testing before they would be reliable enough to use. Many of the larger manufacturers, such as Chrysler Corporation, Automobile Manufacturers Association, and International Harvester, believed the standard would be design restrictive and should be redrafted in terms of performance criteria. White Motor Corporation believed that the proposed standard would decrease safety, not increase it. They were concerned about compatibility of pre- and poststandard vehicles and the lack of service tests of antilock systems. White stated that January 1, 1975, was the earliest effective date that could be met, and it might not be possible to conform to all requirements at that time. The Heavy Duty Truck Manufacturers Association believed the state-of-the-art was not advanced enough to meet the standard and that they had carefully searched all applicable dockets and could find no backup information used as a basis for the NPRM's. They requested that the comment time be extended until such information had been placed in the docket. They also requested that the final report from the University of Michigan contract 16/ be placed in the docket.

The comments from users or owners of vehicles affected by the NPRM's generally agreed with those of the vehicle manufacturers. ATA believed that the test procedures were new and inconsistent with past industry practices; and that it was unrealistic to require antilock devices by January 1, 1972. ATA had initiated field testing of the proposed standard but would not have results before February 1, 1971. The National Association of Motor Bus Owners (NAMBO) strongly believed

16/ R. W. Murphy, et. al., "Bus, Truck . . . ." op. cit.

that the standard was design oriented and that NHTSB should not require equipment until it was fully tested and available from at least two manufacturers. NAMBO commented that the antilock systems hardware would not be available until 1973.

On September 16, 1970, NHTSB announced a technical conference to discuss the two NPRM's and to receive comments pertinent to preparation of the final air brake standard. The conference was held on October 20, 1970. The Heavy Duty Truck Manufacturers Association, brought the following five points to the attention of NHTSB:

- 1) No commercially available friction material (brake linings) could meet the proposed retardation force vs. brake chamber air pressure requirements;
- 2) Since the standard specifies that wheels should not lock, antilock devices would be mandated and there was insufficient test data on the reliability of those devices;
- 3) Split or backup systems would increase the cost and complexity, require more maintenance, and were not needed to meet the stated objectives of the standard;
- 4) NHTSB should adopt a standard for 1972 that reflected the experience shown by the SAE standards; and
- 5) Additional research by NHTSB was required.

#### The Final Rule

On February 19, 1971, the agency, now the National Highway Traffic Safety Administration (NHTSA) issued the final rule on air brake systems. The preamble of the notice discussed many of the comments submitted to the dockets and the technical conference. The stopping distance requirements for trucks and buses on a dry surface were increased "to more accurately reflect the friction characteristics of a surface with a skid number of 75 . . . . The required distance from 60 mph is now 245 feet rather than 216 feet and the distance from 20 mph is 33 feet rather than 29 feet." However, "the stopping distance on a wet surface at 20 mph, 54 feet, has been retained." Several comments had indicated that there were no facilities for high speed testing on wet pavements. In response the NHTSA deleted the high speed test on wet pavement but retained the low speed test stating, "As a measure of brake efficiency, moreover, the 20 mph stop on a wet surface satisfactorily indicates the vehicle's behavior at higher speeds . . . ."

Concerning the stability requirements the NHTSA responded:

The requirement that the vehicle stay within a 12-foot-wide lane has been adopted as proposed. The proposed requirement that no wheel lock except momentarily has been modified to permit lockup to occur on the leading nonsteerable axle on vehicles having more than two nonsteerable axles. A review of available information indicates that satisfactory control of the vehicle can be maintained if lockup is avoided on two nonsteerable axles. The rule also permits lockup at speeds under 10 mph. Such low speed lockup is not considered hazardous and allows greater flexibility in brake system designs.

In response to comments which charged that the standard required antilock devices the NHTSA stated:

Some comments stated that the requirement for a controlled stop without lockup favored one variety of stability-controlling device — the antilock device—over other systems such as load proportioning devices. Several comments seemed to assume that the proposal required antilock devices. The requirement that the vehicle stop without locking its wheels reflects the Administration's judgment that a vehicle with locked wheels, whatever its equipment, is unstable and uncontrollable in an emergency situation. The Administration recognizes the likelihood that manufacturers of some types of vehicles may have to incorporate proportioning or antilock devices into their systems in order to meet the stopping distance requirement. However, the manner in which lockup is prevented is not specified in the standard, and if a proportioning device or any other device can produce the desired result, it may be incorporated into the vehicle's braking system.

Concerning compatibility of vehicles, the NHTSA stated:

The brake retardation force requirement was the subject of numerous comments, some to the effect that the retardation force was too high to permit safe operation of vehicle combinations in which new and old vehicles are mixed, and others to the effect that the forces were too high to be achieved with reliability by available friction materials. The Administration has determined that compatibility problems are substantially lessened if the vehicle has the ability to stop without lockup and that the retention of a relatively high retardation force requirement will not lead to significant compatibility problems. It has been determined, however, that the stopping distance requirements can be met by brakes having a somewhat lower retardation force capacity than proposed and a lower force requirement is therefore adopted.

Many of the equipment requirements were modified which in all cases involved relaxing the requirements. The requirement for a split service system was deleted because "it has been determined that the additional cost and greater complexity of a split system on vehicles equipped with air brakes are not accompanied by safety benefits great enough to justify requiring a split system."

The parking brake criteria for a maximum retardation and automatic application were retained. The rationale stated was that the maximum force had to be specified to prevent wheel lockup during an emergency and that the dangers of automatic application were offset by the required low pressure warning signal.

The NHTSA also explained the intent of the compliance testing portion of the standard. The NHTSA indicated that tolerances were not needed for the testing criteria because the manufacturer was expected to test its vehicles under conditions at least as severe as those specified. They stated that "Manufacturers are required to exercise due care to insure that their vehicles will meet the standard. . . but they are at their own discretion in devising an appropriate testing program . . . ." They cited as an example that a manufacturer could run the stopping tests on a surface with a skid number of 65 to insure that the vehicle would comply when tested on a surface with a skid number of 75.

The NHTSA established an effective date of January 1, 1973 in light of the "development work and preparation for production that this standard will require...."

#### University of Michigan Study

On April 4, 1969, the NHTSB initiated a procurement to "Determine bus, truck and tractor/trailer braking system performance requirements and current performance capabilities to recommend performance standards." The detailed statement of work had received concurrence by most elements of the Federal Highway Administration, including BMCS. The objectives of this research project were:

(1) to establish braking system performance requirements for buses, trucks, and tractor/trailers based on optimum performance capabilities within the limitations of state-of-the-art design techniques, (2) to determine through vehicle testing, the range of current braking system performance of buses, trucks, and tractor/trailers, and (3) to recommend a rational braking system performance standard, or a series of increasingly stringent standards, based on a comparative analysis of the established requirements and current performance capabilities.

On June 23, 1969, a contract to perform the research project was awarded to the Highway Safety Research Institute (HSRI) of the University of Michigan. HSRI proposed to conduct a literature search of braking systems, establish a mathematical model of braking, conduct certain vehicle tests, and make recommendations for a standard on brakes. The initial contract called for the selection and testing of 10 vehicles to establish a state-of-the-art baseline. This testing was split into two phases. Phase 1 tests involved three integral trucks (low, medium, and high performance), an intercity bus, and a schoolbus. Phase 1 was completed by December 9, 1969, when the preliminary results were sent to NHTSB.

On February 11, 1970, the test plan for Phase 2 which consisted of testing various combinations of tractor-trailers, was submitted to the NHTSB. Testing began during the week of April 6, 1970, and was completed by June 10, 1970, at which time test data were forwarded to NHTSB.

On February 25, 1970, the NHTSB contract manager telephoned HSRI to discuss "progress in determining the availability for testing in the near future of vehicles with improved brakes, brake proportioning schemes, and anti-wheel locking systems." The HSRI project manager responded on March 10, 1970, with a letter detailing cost estimates of expanding the testing to include advanced braking systems. That letter constitutes the earliest reference in the contract file to any testing of advanced braking systems.

On April 20, 1970, justification for a modification to the HSRI contract was proposed which stated, "This increased scope is necessary since NHTSB is planning to promulgate standards in this area in the immediate future. Since these standards are designed to push the state-of-the-art, a valid and complete data base for performance capabilities must be established." The vehicles and braking systems to be tested were selected by NHTSB and specified in the contract modification.

The trucks to be tested consisted of:

- 1) An integral truck equipped with a full power hydraulic disc brake system by Bendix.
- 2) A tractor-trailer combination with a special brake configuration consisting of: Bendix-Westinghouse adaptive braking -- antilock; Berg "Synchron" -- special devices to improve brake timing; and a Borg-Warner load proportioning braking device.

The modification to the contract was effective on April 23, 1970, and testing on the advanced braking system trucks began on July 1, 1970. Throughout the testing, both vehicles encountered numerous problems with the braking systems. In particular, the tractor-trailer malfunctioned for two reasons: The foundation brakes were incapable of producing the decelerations needed for the tests, and most of the advanced systems were prototypical and not reflective of production models. The testing of the tractor-trailer was sharply curtailed and eventually discontinued on October 12, 1970. In its place a tractor-trailer combination vehicle equipped with an Eaton, Yale, and Towne antilock system and more aggressive foundation brakes was tested. This replacement vehicle also encountered problems, specifically vibrations in the tractor front brakes. Testing was not completed until November 13, 1970, when the data for that vehicle were forwarded to NHTSB.

The results of the testing were used by HSRI to compare the maximum achievable decelerations of both the baseline and advanced systems. Those results indicated that, "a truck, bus or tractor-trailer with brakes balanced for maximum braking performance can exceed the performance achieved on a dry surface by advanced brake control systems." However, the maximum deceleration achieved is a function of the tire-road interface and, therefore, very dependent on the tractive capability of the vehicle tires. To test the effect of the advanced systems, the tractor-trailers were run twice; first with the advanced systems operative and second with them bypassed. These results showed that the advanced systems achieved higher maximum decelerations (without wheel lockup). These improvements were most obvious on low coefficient of friction surfaces and when the vehicle was empty. The minimum stopping distances achieved by the vehicles were not directly comparable with the requirements of FMVSS 121 in that the skid number of the test track used was 85 versus 75 specified in the standard. However, the stopping distances obtained in the HSRI report data were corrected for the skid number difference and used to determine the performance criteria of the final rule. The HSRI data were the main criteria used to relax the standard from 216 feet in the NPRM to 245 feet in the final rule.

The final report of the HSRI study was dated March 1971 and included recommendations for a three-phase plan for implementation of a standard. A time schedule for each phase was not specified because "information on lead times for introduction of design changes, development of new hardware and necessary manufacturing techniques [was] not generally available from vehicle, brake, and brake component manufacturers."

The recommended approach to the standard was outlined as follows:

As a first step, it is recommended that the rules require immediate action to upgrade braking performance to a level achievable by current design practice, that is, the best performance already demonstrated by baseline vehicles tested. For the second step it is recommended that the rules require performance to be improved to the limit of the tire-road interface tractive capabilities of truck tires now available with due regard to realistic braking efficiencies. The second step may require use of load sensitive proportioning systems on certain vehicles, and therefore sufficient lead time should be allowed for further development and testing of these devices. After an appropriate time interval to allow for development and testing of a reliable antilock system, the development of truck tires with better tractive characteristics, and the necessary design modifications of vehicle brake, suspension, and structural systems, it is recommended as a third step that performance equal to or approaching that of passenger cars be required along with use of an antilock system to insure vehicle stability over a wide range of vehicle loadings and road surface conditions.

#### Petitions for Reconsideration

After the final rule for FMVSS 121 was issued on February 19, 1971, Petitions for Reconsideration were submitted by 11 vehicle manufacturers, 10 brake component manufacturers, and 6 operator groups. The most frequent comment in the petitions was that the January 1, 1973, effective date could not be met because there were insufficient test data to support predictions of compliance and reliability. Seven of the vehicle manufacturers petitioned for later effective dates because of factors such as: The unproven nature of antilock devices, the vast amount of vehicle redesign required, and the need for testing and coordination with component suppliers. Five brake component manufacturers claimed that the January 1, 1973, date could not be met because sufficient field testing of antilock devices would not be completed by that time. The longest delay requested in the petitions proposed an effective date of January 1, 1975.

The "no wheel-lockup" requirement was questioned by eight of the vehicle manufacturers, one component manufacturer, and two operator groups. The petitions claimed that antilock devices had not been proven reliable and should not be mandated. Three vehicle manufacturers and three component manufacturers petitioned for increases in the stopping distances. The vehicle manufacturers claimed that the stopping distances could only be met with antilock devices and should, therefore, be increased. The component manufacturers claimed that the available brake linings were speed-sensitive and could not meet the high speed stopping distances mandated in the standard.

Other aspects of the standard which were petitioned included: The cost involved to achieve compliance, the availability of test facilities, the automatic application of parking brakes, the antilock "total failure" requirements for a warning, and the dynamometer testing requirements.

One of the Petitions for Reconsideration was submitted by the National Motor Vehicle Safety Advisory Council. At a meeting of the council on May 13, 1971, a resolution was passed and forwarded to the Secretary of Transportation calling for the NHTSA to "issue a 'staircase' type of long-range requirement for air brake systems. . . ." The council recommended that at minimum a two-step approach to regulating air brakes be adopted. The first step would have required conformance to "current existing standards of good engineering design. . . ." Increased levels of performance would then be required for succeeding years and would be announced in advance to allow tooling changes. The council further recommended that the NHTSA consider the following five points in modifying FMVSS 121:

- 1) That the standard be redrafted in performance terms in order to allow manufacturers to choose the most cost effective designs to meet the standard;
- 2) That the comments in the dockets indicated that equipment was not available to meet the standard's criteria, and even if it were available extensive redesign of other aspects of vehicles (e.g., the suspension system) would be required to withstand the specified deceleration rates;
- 3) That comments to the docket indicated that adequate facilities were not available to test vehicles at the speeds and under the road surface conditions specified by the standard;
- 4) That the timing of the applicable dates of the standard be extended over a period of time sufficient to avert major compatibility problems between pre-and poststandard vehicles; and
- 5) That since there was little or no field experience with antilock devices, the implementation of the standard be extended over a period of time which would allow for sufficient testing and development.

#### First Amendment to FMVSS 121

The NHTSA responded to the Petitions for Reconsideration by issuing an amendment to the standard on February 16, 1972. The response draft was completed on August 1, 1971, and circulated for clearance within the NHTSA until it was issued in February 1972. The NHTSA response addressed those petitions which had been received before August 1, 1971.

The effective date was extended to September 1, 1974, which "would permit a longer period of fleet testing to evaluate the durability of the new systems . . . ." It was stated that ". . . the resulting production systems [were] likely to be substantially improved by the additional time allowed."

The specification of a skid number of 75 for dry surfaces was retained because it "is representative of road surfaces, and has been a part of the consumer information requirements long enough that the availability of skid pads should not be a problem."

The petitions to delete dynamometer testing were denied. In that regard the NHTSA stated, "the agency recognizes that the availability of dynamometers of sufficient capacity is a concern to many petitioners, but available evidence indicates that dynamometer access will not be a major long term problem."

The reference to "momentary" lockup of wheels was amended by use of the term "controlled" lockup. The requirement for antilock failure warning was changed to require a warning in "the event of electrical failure." The requirement for automatic application of parking brakes was changed to permit such systems but not require them. The NPRM also stated that, "The distances are considered reasonable and well within the state-of-the art. Greater distances would increase the disparity between trucks and cars and be contrary to the interests of safety."

The petitions concerning the unproven reliability and field testing of antilock systems were not directly mentioned in the Notice. The extension of the effective date was the only reference to field testing of new componentry.

#### Other Reactions to FMVSS 121

Comments on FMVSS 121 were also sent to the NHTSA by parties not directly related to the commercial vehicle industry.

For example, the Department of Transportation for the Commonwealth of Pennsylvania submitted two accident investigation reports. The first indicated that according to their data files 56 percent of truck accidents involving brakes were caused by overheated brakes. They recommended that the NHTSA initiate rulemaking to require all truck-tractor units to be equipped with integral engine brakes and to require an increase in the amount of foundation braking surface provided. The second report involved a collision between a passenger car and a tractor and semitrailer. The brake system of the tractor-trailer was rated as totally inadequate when the vehicle was loaded to its maximum gross weight. They recommended that the maximum load limitations be lowered; that brake lining specifications be mandated; that the stopping ability of trucks be the same for loaded and unloaded conditions; and that a dual brake system be required.

Two reports were submitted by the National Transportation Safety Board. One was a highway accident investigation report of a multiple-vehicle collision on U.S. 101 north of Ventura, California, on August 18, 1971. 17/ The report was adopted by the Safety Board on July 6, 1972, and listed the probable cause, in part, as "...the failure of a tractor-semitrailer, moving at posted speed, to reduce its speed sufficiently to avoid collision with stopped and slow-moving vehicles ahead." Based on the findings of the report, the Safety Board issued the following recommendation to the NHTSA:

...continue the commendable efforts exemplified in Federal Motor Vehicle Safety Standard No. 121, effective September 1, 1974, toward more effective braking performance requirements for trucks, trailers, and certain vehicle combinations, not only toward closer compatibility between the performance criteria for truck and passenger-car braking, but toward more extensive use

17/ Highway Accident Report: "Multiple-Vehicle Collisions and Fires, U.S. 101 North of Ventura, California," August 18, 1971 (NTSB-HAR-72-4).

of available technology. Continuing effort toward such improved truck braking is essential in recognition of the basic fact that the potential to inflict destruction and death is proportional to weight, at equal speeds, and that the control of truck speed under all reasonably foreseeable conditions, and especially when heavily laden, is vital to the safety of all highway users.

The second report was a special study on commercial motor vehicle braking adopted by the Safety Board on November 22, 1972. <sup>18/</sup> The study was motivated by several accident investigations in which braking was a causal factor. That study discussed "the need for regulatory agencies, vehicle manufacturers and brake suppliers to incorporate (vastly) improved braking technology in commercial motor vehicle designs." The Safety Board recommended that "...Federal funds be made available to design, build and test an Experimental Safety Vehicle. . . ." The Safety Board cited as specific examples of advanced technology "hydraulically actuated, anti-skid, disc-type brakes with a supplemental energy absorption system. . . ." The Safety Board referred to the disparity between the stopping distances of commercial motor vehicles and passenger cars and its finding that "improvements in truck braking. . . have not kept pace with increasing demands on braking systems." The Safety Board recommended that the NHTSA coordinate an experimental safety vehicle testing program to test the advanced technology of other disciplines (such as aviation disc brakes) to advance the state-of-the-art in commercial vehicle braking.

Another significant submission was a letter from Mr. Ralph Nader, dated February 22, 1972. Enclosed with the letter was a paper, "An Analysis of the Major Deficiencies of the Federal Motor Vehicle Safety Standards," by Dr. Carl Nash. Mr. Nader raised the following points concerning FMVSS 131:

- 1) That stopping distances for trucks and buses should not be longer than for passenger cars;
- 2) that high-speed stops on wet pavement were not specified in the standard;
- 3) that the requirements for an antilock system were weak; and
- 4) that the effective date had been unreasonably postponed.

In the NHTSA response, dated June 21, 1972, the Administrator stated:

Although it is conceivable that air brakes could be designed so that all trucks could stop in a distance equal to that of a passenger car, we do not consider such performance to be practicable at this time. Taken as a whole, the standard requires a significant upgrading of all aspects of brake performance, not just in stopping capability. We think that it will eliminate most of the problem of incompatibility between cars and trucks.

<sup>18/</sup> Special Study: "Commercial Vehicle Braking", November 22, 1972, (NTSB-HSS-72-5).

Although the standard does not require a high speed stop under wet road conditions, the combination of the high speed stop on dry pavement and the 20 mph stop on wet pavement give us a good indication of the brake systems' behavior at high speeds on wet pavement without the need for the extensive facilities that such tests would require. An antilock system that is capable of meeting the criteria in the standard should be capable of satisfactory performance under all conditions.

The effective date of the standard was postponed in consideration of the fact that the standard would require complete system redesign in many cases. With a system such as the brake system, which must continue to give adequate performance for hundreds of thousands of miles, we agreed with the manufacturers that new systems should be given extensive fleet use prior to the effective date of the standard.

#### Major Modifications Before Implementation of the Standard

After the first amendment to FMVSS 121 was issued on February 16, 1972, several new Petitions for Reconsideration were filed. These petitions led to a series of notices from the NHTSA. Over a period of 3 years before the standard was effective, the NHTSA responded to repeated industry requests by issuing NPRM's and amendments to the standard.

The first of these notices was issued on June 21, 1972. Petitions of International Harvester and General Motors were granted in part to modify the requirements for an antilock warning device. Requests from the Carlisle Corporation to increase the stopping distances were denied because the NHTSA determined that "...the distances specified are considered to be appropriate and within the current state of the art." International Harvester repeticioned against the use of a skid number of 75 for road tests. The NHTSA indicated that additional data would be collected concerning road surfaces with a view to possible future changes.

On June 21, 1972, the NHTSA also issued an NPRM proposing changes to the loading conditions for truck-tractors and the wind velocity test conditions. Interested parties were given until August 7, 1972, to comment. On August 9, 1972, the comment period was extended to October 25, 1972, in response to a petition submitted by the Freightliner Corporation.

On March 7, 1973, the NHTSA issued another NPRM. This NPRM responded to a petition for rulemaking by Ford Motor Company which requested increased emergency stopping distances for unloaded truck-tractors. The proposed stopping distances were to be determined by a formula using the vehicle's weight distribution. The period for comment ended on April 15, 1973.

On June 1, 1973, the NHTSA issued yet another NPRM. This NPRM addressed three general areas:

- 1) Amendments to the parking brake and emergency brake requirements as requested by the American Trucking Associations, Inc. (ATA);
- 2) changes to the test conditions for truck-tractors; and
- 3) a variety of remedial actions and responses to petitions.

At the request of ATA, the NHTSA held a public meeting on October 25, 1972, to discuss objections to the automatic parking brake provision of the standard. As a result of that meeting and a subsequent ATA petition, the NHTSA proposed to eliminate the use of automatic parking brakes as the emergency or secondary brake system. The proposal allowed the use of automatic parking brakes but required the manufacturer to install a secondary system capable of modulation.

This Notice also modified the two earlier NPRM's (issued on June 21, 1972, and March 7, 1973) which were not yet adopted. The comment period closed on July 16, 1973.

Comments submitted in response to this NPRM expressed manufacturer concern over the lead time required for the changes. Bendix Corporation stated that they and other manufacturers had spent the previous 16 months conducting extensive testing to achieve the requirements of the standard. In their opinion the proposed changes would invalidate those test results and require the redesign and development of new components. The Wagner Electric Corporation referred to "an impossible situation within the truck and supplier industry." Wagner requested an early resolution of any proposed changes so that they would be able to determine how to plan their production. Rockwell International stated that it was impossible to generate enough test data to certify the required stopping distances for certain vehicles with several axle options and recommended that these vehicles be exempted from the stopping distance requirements for an additional 24 months.

On August 22, 1973, the NHTSA published a notice in the Federal Register announcing a public demonstration to evaluate the compatibility of pre- and post-FMVSS 121 vehicles. In November 1973 this public demonstration was held at East Liberty, Ohio and, at low road speeds, it showed antilock devices to be effective without significant compatibility problems.

On November 8, 1973, while the East Liberty demonstration was being held, the General Motors Corporation submitted a petition to the NHTSA to delay the effective date of FMVSS 121 until field tests indicated a reliable anti-lock system was available for mass production. This petition was followed by several other petitions for delay of the standard.

On December 20, 1973, the NHTSA amended the standard as proposed on June 1, 1973, with a modification of the emergency stopping distance requirements for truck-tractors, a change to the recovery requirements for antilock-equipped brakes; and new test conditions. The NHTSA stated that the comments on the NPRM revealed an "overriding concern with lead time." However, the NHTSA also stated that, for its part, it did "... not consider the proposed changes significant enough to warrant postponing the effective date of the standard." The proposed revisions to the emergency and parking brake systems, as petitioned by ATA, were not adopted. The NHTSA stated that the issues had merit, but in light of the lead time requirements they would be considered at a later date and, if adopted, would have an effective date after September 1, 1974.

On February 25, 1974, the NHTSA issued another NPRM in response to petitions received from 36 manufacturers of vehicles and suppliers of components. The NHTSA stated that most requests to modify the standard were "prompted by uncertainty as to the availability and reliability of the necessary components

involved in these changes." The NHTSA felt that the equipment requirements were within the existing state-of-the-art; therefore, the NHTSA proposed only those modifications which were considered essential to implement the standard as rapidly and fully as possible. The NPRM proposed delaying the effective dates for trucks and buses to January 1, 1975; limiting the applicability of FMVSS 121 to firefighting vehicles until September 1, 1975; exempting oversized vehicles until September 1, 1976; and suspending the stopping distance requirement for "on/off" highway vehicles until September 1, 1975.

Concerning highway trucks and buses the NHTSA stated:

The overriding issue, as expressed by General Motors, Freightliner, Ford, Mack, and Diamond Reo, is the introduction of antilock on vehicles which have high-torque front brakes. Most questioned the reliability of antilock systems based on their test programs and believed that a driver's inability to modulate the new high-torque brakes in the event of sudden failure of the antilock would be disastrous.

The NHTSA has found that antilock systems are reliable and offer significant improvement in vehicle braking characteristics. In this agency's judgement, the argument by General Motors that drivers will uncritically rely on the antilock system for brake modulation, and that these systems will fail without warning, causing lock-up and loss of control, does not take sufficient account of the design and function of antilock systems.

The systems permit fast, stable deceleration in emergency situations. A driver will not rely on this type of deceleration for routine maneuvers because of the discomfort to him and danger of load shifts associated with panic stops. In any case, separate antilock systems are provided on each axle so that a failure in one system has only a limited effect on vehicle control. In the event of total electrical failure, a signal is required in the cab to give a continuous warning of that failure to a person in the normal driving position. Viewed as a whole, the antilock system (if utilized by a manufacturer) will provide greater stability in braking maneuvers than is available in today's vehicles without antilock systems.

The NHTSA also proposed allowing the use of manually-operated valves to reduce chamber pressure, and therefore the braking force, available to the front brakes.

In response to a request from International Harvester, the NHTSA proposed a temporary 5-percent increase in stopping distances to be effective until September 1, 1975, to allow for production variations. The deadline for comments was April 1, 1974.

On May 14, 1974, the NHTSA issued a lengthy notice which reconsidered many of the amendments to FMVSS 121 made on December 20, 1973, and amended the standard based on comments received on the February 25, 1974, NPRM. The NHTSA denied an ATA request to reconsider the emergency system modifications, stating that those changes could not be met by all manufacturers by the effective date of the standard. Portions of the test conditions and procedures were clarified

by the NHTSA at the request of manufacturers such as General Motors, Wagner Electric, Motor Vehicle Manufacturers Association (MVMA—formerly AMA), Ford Motor Company, and Midland-Ross. In response to the comments received on the February 25, 1974, NPRM, the NHTSA adopted the proposed modifications of effective dates for firefighting vehicles, "special permit" vehicles, and "on/off" highway vehicles.

In this Notice the NHTSA also delayed the effective date of the standard for trucks and buses until March 1, 1975, which partially answered the requests of many manufacturers, including Ford Motor Company, General Motors, Chrysler Corporation, Rockwell International and Blue Bird Body Company. (International Harvester had agreed with a 4-month delay and indicated that they would start production at that time.) The NHTSA stated:

General Motors and other truck manufacturers argued for delay of the standard's effective date for one year to permit additional field testing of the reliability of current antilock devices. The likely effect of such a delay, however, would be further delay in the availability of production antilock components. One air brake equipment supplier believes "continued development will eventually improve their (antilock systems) overall performance but most of these changes for refinement in electronics, improved pneumatic/electronic response, durability, sensor standardization and design standards require the normal evolution of field experience under real life conditions, using mass produced parts for a genuine field history."

The reliability of antilock systems can presently be judged on the basis of the performance of systems that are already in fleet test programs (and to a lesser extent by evaluation of antilock systems used for many years in passenger cars). One truck manufacturer has reported average miles between failures on fleet testing to be 89,000 miles (176,000 miles in operations within the continental United States). A manufacturer of antilock equipment reported in February 1974 that over 8,000 of its air brake skid control systems are in field use, with excellent reliability experienced.

Neither this manufacturer nor any other has reported any highway accident which was attributed to a malfunction of the antilock system.

The NHTSA also adopted the proposed amendment for a temporary increase of 5 percent in the stopping distance requirements. Manufacturers had requested an indefinite extension. The NHTSA denied this request and made the temporary increase effective until September 1, 1975.

On May 14, 1974, the NHTSA also issued an NPRM proposing to delay the effective date of FMVSS 121 for trailers. Because of reported shortages in some related equipment components, the NHTSA proposed to delay the effective date for trailers until January 1, 1975, and for a category of "specialized trailers" (defined as heavy hauler trailers) until September 1, 1976. The closing date for comments was June 17, 1974.

On May 23, 1974, the NHTSA issued another notice shortening the period for comment to June 4, 1974. The stated rationale for shortening the comment period was that numerous trailer manufacturers had indicated that the effective date would have to be firmly established before late June because of contractual complications.

On June 6, 1974, the NHTSA issued an amendment to FMVSS 121 delaying the effective date for trailers until January 1, 1975. The issue of the effective date for the "specialized trailers" was left open for further comment. The NHTSA stated that the delay was justified because the "... September 1, 1974, date does not provide sufficient time for an orderly transition to production of the trailers with the new components. ..."

On July 30, 1974, the NHTSA issued an amendment which delayed the effective date for the "specialized trailers" until September 1, 1976. Specific guidelines for the definition of "specialized trailers" were included in the standard.

In response to six petitions for reconsideration the NHTSA amended FMVSS 121 on November 6, 1974. The Notice covered six major issues:

1. Ford Motor Company, Chrysler Corporation, and the American Institute of Merchant Shipping had petitioned for delays in the standard. For example, Ford had petitioned for a 6-month delay for truck-tractors and a 1 1/2-year delay for other trucks and buses citing the increased forces placed on components and the unproven reliability of antilock devices. The NHTSA rejected the petition and concluded that implementation of the standard was reasonable, practicable, and met the needs for motor vehicle safety.
2. Some of the petitions stated that major redesigns would be required to eliminate handling and stability problems experienced by some short-wheelbased vehicles. The NHTSA maintained that adequate lead time had been provided for redesign of these vehicles or to "make the decision to discontinue the production of models which are simply too short to meet the requirements despite design changes."
3. Concerning availability of antilock devices, the NHTSA stated:

The availability and reliability of antilock systems which will be used by many manufacturers in meeting the requirements was questioned by Ford in its petition. In response to Ford's assertion that a manufacturer's report on field experience with 8,000 antilock units does not appear in the record, a letter from Kelsey-Hayes (February 1, 1974) containing this information was placed in the NHTSA Docket Section before March 1, 1974. The NHTSA continues to monitor antilock production and testing and cannot agree that the evidence indicates antilocks will decrease the safety of the new trucks in highway operation. Since May, the NHTSA engineering staff has visited six of the seven major antilock manufacturers to discuss antilock reliability. At least half of these manufacturers pointed out that their plants were prepared for full production to meet the September 1, 1974, date, and that they had had to delay production schedules because of the six-month delay. Low volume production is presently available to vehicle manufacturers for their testing and evaluation.

4. Chrysler Corporation had reported a proving ground accident involving an antilock equipped vehicle. The NHTSA evaluated the accident and pointed out that "the manufacturer of the antilock system reported that the device functioned as it was designed to but in response to a false signal." The NHTSA concluded that the accident would also have happened if the vehicle had not been equipped with an antilock system, and that vehicles without antilock systems were more likely to have accidents in such panic stops than vehicles with antilock systems.
5. White Motor Corporation, International Harvester, and Diamond Reo Trucks, Inc., had petitioned for relaxation of the stopping distances for vehicles equipped with front steerable drive axles after September 1, 1975. The NHTSA responded by delaying the effective date (for stopping distances) to September 1, 1976, for these vehicles.
6. Diamond Reo had also petitioned that the temporary increases in stopping distances be made permanent. They claimed that the longer stopping distances were necessary to ensure compliance with the standard by all of their vehicles. The NHTSA responded that manufacturers were required to "exercise due care" in certifying their vehicles, and that the law allowed for latitude; therefore the petition was denied.

On November 11, 1974, the NHTSA proposed to exempt a small category of oversized and construction vehicles. The NPRM also contained a new test procedure for specialized tractor-trailer combinations, such as automobile transporters. The closing date for comment on the proposed changes was December 16, 1974.

On December 16, 1974, the NHTSA issued an NPRM which appeared in the Federal Register on December 17, 1974. The NPRM proposed postponing the effective dates of FMVSS 121 in light of the current economic situation. The NHTSA solicited—

. . . further information on the economic impact of Standard No. 121, both on individual companies and on the nation as a whole, specifically in light of the present economic situation.

In addition to comments on the general economic effect of the air brake standard, the NHTSA requests comments from companies that are directly affected by the standard, as equipment suppliers or vehicle manufacturers, distributors, dealers, or users. Questions of special interest are: What has been and what will be the effect on your company of Standard No. 121, assuming that it goes into effect as currently issued? What would be the effect on your company if the standard's effectiveness were postponed 3 months, 6 months, 1 year, or indefinitely? What action would your company take if the standard were postponed as above? Comments are particularly requested on the effect of these postponements on your organization with respect to sales, prices, employment, and outside procurement.

The closing date for comments was December 26, 1974.

In response to a petition of Breeze Corporations, Inc. (a manufacturer of an anti-jackknife device), the NHTSA issued a Notice on December 18, 1974, describing the rationale for requiring the "no wheel-lockup" provision. The NHTSA stated that, "a vehicle whose wheels are locked is likely to slide sideways as a result of such conditions as unevenness or banking in the road surface, wind forces, impacts on or by another vehicle, or steering inputs by the driver as a result either of the emergency situation or of curve in the road." The NHTSA stated that, "safe braking capability must take into account the other variables that affect braking performance, and the prohibition against locking is included in the requirement to assure safe braking under such other conditions." The NHTSA stated that it did not anticipate making any further amendments to the standard as a result of this Notice, but was interested in receiving comments that any interested party wanted to submit for the public record.

On December 31, 1974, the NHTSA issued a Notice indicating that the effective dates of the standard would not be postponed but that the agency would continue to "monitor the effectiveness of the standard as vehicles conforming to its requirements enter the stream of traffic, with a view to any modifications that would lower costs while achieving comparable levels of safety." The NHTSA stated that:

Analysis of the comments indicates that the net short-term economic consequences of delay in this standard would be negative. The principal factor dictating this conclusion is the standard's imminent effectiveness on January 1, 1975, and March 1, 1975. The effective dates are so near that the preparations and commitments, with all their economic ramifications, have already occurred and are substantially irreversible in the short run.

The NHTSA also stated that:

Several manufacturers noted difficulties that they have experienced in obtaining components needed to make their vehicles conform to the standard. The NHTSA invites such persons to notify this agency of such problems, both for informational purposes and for any assistance the agency might render in obtaining proper attention from suppliers. Producers of fewer than 10,000 vehicles per year should also be aware of the procedure for obtaining a temporary exemption on the ground of economic hardship (49 CFR Part 555). Inability to obtain needed supplies could qualify as a basis for such an exemption.

The following is a summary of the comments received by the NHTSA as of December 31, 1974, in response to the December 18, 1974 NPRM. Only those comments which expressed a view concerning delay of the standard have been tabulated.

- o All of the major antilock component manufacturers were opposed to any delay of the standard.
- o Of the 40 comments received from vehicle component suppliers, 17 expressed a desire for a delay (of some duration), and 23 requested no delay in the effective date.
- o Of the 136 comments received from vehicle manufacturers, 14 supported implementation of the standard as scheduled and 122 supported delay. The following major truck manufacturers opposed a delay of the standard: International Harvester, Oshkosh Truck Corp., and Chrysler Corporation.
- o Of the 131 comments received from users of vehicles, 126 were for delaying the effective date and 5 were not.
- o Of the 31 comments received from nonindustry organizations or members of the public, 23 were opposed to any delay and 8 were for at least some delay in the effective date.

The majority of comments submitted in response to the NPRM were prepared on short notice and many of the manufacturers stated that they were unable to offer specific data because the time allowed for comment was too short.

The NHTSA also issued an amendment to the standard on December 31, 1974. That amendment adopted the changes proposed on November 11, 1974, for categories of specialized trailers, established a new test category for highly specialized tractor-trailer vehicle combinations, such as auto transporters, and temporarily reduced the brake retardation criteria for trailers until September 1, 1976. The NHTSA also modified the definition of the specialized tractor-trailers in response to comments from manufacturers and users of auto transporters and the TTMA.

#### System Reliability

On August 7, 1974, the NHTSA sent each major manufacturer of antilock brake systems a letter which requested information regarding production readiness and capacity, and system reliability. All of the manufacturers responded with proprietary information which was not made available to the public.

An independent evaluation of the reliability data was also performed by the Office of the Secretary of Transportation. In a memorandum to the Acting Assistant Secretary for Systems Development and Technology, dated January 2, 1975, the staff analyst stated:

I completed this summary with a feeling of confidence with respect to most of the available systems, and minor concern with respect to others. The marriages of the relatively well-proven antilock brake system with the fleet tested trailers should wear well in service provided the maintenance is good.

The reliability problems are going to be encountered by the many small trailer manufacturers whose trailers are mated with the antilock systems that have not had comprehensive test programs conducted on their hardware. These trailer manufacturers were too small to finance fleet testing or have no facilities for laboratory or proving ground tests. Judging from the docket responses their primary concern about antilock is their lack of familiarity and experience with them. These manufacturers are going to have both installation and maintenance problems affecting reliability. Postponing the standard on their behalf would probably not solve this potential problem.

While it would appear that certain manufacturers could definitely benefit from additional homework, I saw no evidence in the overall status of braking system reliability that would justify a further delay in FMVSS 121.

A review of the submissions by all manufacturers of antilock systems in response to Notice 8 19/ reveals no tendency to ask for a delay by any of them, except for. . . where their campaign for delay of all standards for at least 3 years prevails as a matter of corporate policy.

It is my conclusion that antilock braking system reliability is about as good as can be expected without the benefit of full service experience.

#### Cost-Benefit Analysis of FMVSS 121

The earliest cost-benefit analyses performed for FMVSS 121 were a "rough" economic analysis of the standard drafted in 1971 and a benefit analysis prepared in 1972. These two analyses were also the only cost-benefit studies completed by the NHTSA before the standard's implementation. The sources of accident data used by the NHTSA were published reports of the Bureau of Motor Carrier Safety (BMCS) for the year 1969. These analyses were subsequently referred to as the NHTSA "in house" study for cost-benefit.

On April 28, 1975, the NHTSA completed a working draft economic analysis of the impact of FMVSS 121 entitled "A 'Quick-Look' Evaluation" and placed it in the public docket on October 24, 1975. This document was designed as a first step in the evaluation of FMVSS 121. The benefit estimates were based on 1972 BMCS accident data and the cost estimates on data "from representative high volume manufacturers." The cost figures included the full profit margins for manufacturers and dealers.

The "Quick-Look" Evaluation was performed at the urging of the Council on Wage and Price Stability (CWPS). CWPS is an independent government agency which was formed on August 24, 1974, and was charged with intervening in rulemaking proceedings before other government agencies in order to present its views on inflationary impact. CWPS became interested in FMVSS 121 because of an open letter to the President of the United States which appeared in the Washington Post on November 26, 1974. The letter was placed by the Breeze Corporations, Inc. of Union, New Jersey, and complained about the criteria of FMVSS 121.

19/ Issued by the NHTSA as an NPRM on December 16, 1974.

CWPS reviewed the analyses that the NHTSA performed for PMVSS 121 and at a NHTSA public meeting on October 30, 1975 summarized its findings as follows:

. . . A meeting with NHTSA officials revealed that the NHTSA had conducted an analysis of the standard's likely economic effects. We requested that we be supplied with a copy of this analysis and were, but were told that it was an in-house study and that we should not reveal its existence. For this reason, we did not refer to this analysis in the Council's public filing of December 26, but we did state that agency analyses in general should be made part of the public record and we urged the NHTSA to delay implementation pending a detailed study of its economic impact.

\* \* \* \*

. . . Thereafter, the NHTSA decided to proceed with the implementation of the standard on January 1st and did not respond to our request for public disclosure.

\* \* \* \*

As a result of our discussions and the objections we raised, the NHTSA agreed to perform a more complete economic analysis of the likely effects of the standard, including the indirect costs associated with the standard which in the original analysis were largely ignored.

The outcome was the so-called "quick look" study which was submitted on a confidential basis to the Council in May and which was released earlier this month. This analysis was reviewed by the Council's staff.

This quick look study contained far better cost analysis than the previous study. Indeed we no longer disagreed much on the cost side. However, we still found the NHTSA's analysis deficient insofar as the level of benefits was concerned. . . .

The CWPS criticism of the NHTSA "in-house" study centered around its failure to adequately address such indirect costs of the standard as loss of revenue because of vehicle equipment weight increases (and consequently lower cargo capacity) to meet equipment requirements of the standard and increased maintenance costs. CWPS criticized the benefit analysis for overestimating the benefits and combining buses and trucks under a single accident rate. CWPS recalculated the cost-benefit ratios arrived at by the NHTSA, producing lower ratios.

The CWPS review of the "Quick-Look" Evaluation resulted in three main criticisms:

- 1) That the underlying data used consisted of accident summaries — not the actual files — which led to overestimation of the benefits. This was compounded by a two stage extrapolation of the relatively small sample, thereby magnifying any errors in the evaluation of the sample;

2) that the NHTSA had made no attempt to separate the effects of various subcomponents of the standard. This was considered necessary because of the controversy surrounding antilock devices; and

3) that the analysis was not separated for buses, integral trucks, and multi-unit trucks. The CWPS believed that economically, a strong case could be made for buses, but that the case for multi-unit trucks and especially integral trucks was very weak.

January 1975 to March 1976

During the initial period after the effective date of the standard, the NHTSA responded to several petitions and initiated a number of NPRM's and amendments. The following is a synopsis of those Notices:

- o January 10, 1975 -- The NHTSA amended the emergency brake system requirements, effective September 1, 1976. This amendment responded to a December 1972 ATA petition which was the subject of an NPRM in June 1973 and mentioned again in January 1974. The amendment deleted the emergency brake option, which for trucks and buses permitted automatic application of parking brakes.
- o January 23, 1975 -- The NHTSA proposed an exemption for a category of oversized and construction vehicles, expanding the proposal of November 11, 1974.
- o February 28, 1975 -- the NHTSA amended the standard to exempt oversized and construction vehicles. The definition of these vehicles was modified and included vehicles which were not designed to carry passengers or cargo and were incapable of reaching highway speeds (45 mph).
- o March 14, 1975 -- The NHTSA responded to a number of petitions for reconsideration of the requirements of the standard related to stopping distances and brake retardation forces. All of these petitions were denied with the exception of one applicable to "on/off" highway vehicles.
- o March 20, 1975 -- The NHTSA proposed an exemption from the emergency and parking brake requirements, until January 1, 1976, for agricultural commodity trailers.
- o April 29, 1975 -- The NHTSA issued an NPRM proposing criteria for determining the conditions under which a truck assembled by combining new and used components may be considered "new" for the purposes of the motor vehicle safety standards.
- o May 12, 1975 -- The NHTSA responded to three petitions for reconsideration of the effective dates of the standard. These petitions were denied with the exception that the effective date for firefighting apparatus was amended to March 1, 1976.

- o June 6, 1975 — The NHTSA, in response to a number of petitions from manufacturers, proposed increasing the stopping distance requirements for dry pavement testing until January 1, 1978; increasing brake actuation times; and excluding certain trailers and vehicles from the standard.
- o June 25, 1975 — The NHTSA announced it would not amend the standard for agricultural commodity trailers as earlier proposed.
- o July 23, 1975 — The NHTSA, in response to six petitions, modified the emergency brake amendment of January 10, 1975. This modification withdrew a test requirement for a minimum number of applications and releases that was to become effective on September 1, 1976.
- o August 25, 1975 — The NHTSA amended the standard to temporarily increase the stopping distances on a dry surface until January 1, 1978. The amendment increased the temporary stopping distances which were to be effective until September 1, 1975. The amendment also adopted the proposed changes in brake actuation times and exempted certain specialized trailers and other vehicles.
- o September 16, 1975 — The NHTSA announced a public meeting on FMVSS 121 to be held October 29-31, 1975. The Notice referred to reports of improperly operating brake systems, increased maintenance costs, the potential problem of radio transmission interference, and possible unsafe braking performance. The purpose of the meeting was to gather information from the public on field experience and to assess the effectiveness of FMVSS 121.
- o September 24, 1975 — The NHTSA proposed to modify the method of determining the skid number of a surface and to make corresponding changes to the skid numbers used in various braking standards.
- o October 16, 1975 — The NHTSA adopted criteria for determining the applicability of FMVSS 121 and other safety standards to trucks assembled with a combination of new and used components. The Notice stated that:

Standard No. 121, Air Brake Systems, has heightened the importance of the question of what constitutes a new vehicle, since bringing vehicles with pre-121 axles into conformity with the standard appears to be economically impracticable.
- o October 29-31, 1975 -- The NHTSA held a public hearing. See separate section.
- o November 11, 1975 — The NHTSA proposed suspending the stopping distance requirement without wheel lockup for buses until January 1, 1977. The proposal was in response to information gathered at the October 29-31, 1975, public meeting.

- o November 28, 1975 — The NHTSA amended the standard to change the emergency and parking brake requirements for a redefined group of agricultural commodity trailers until March 1, 1976.
- o December 1, 1975 — The NHTSA, in response to numerous comments and petitions, proposed to restructure the format of the standard, established new standardized brake controls, and made other modifications. Many of the changes had been requested by the California Highway Patrol, ATA, and others.
- o December 9, 1975 — The NHTSA proposed a definition of when a rebuilt trailer would be considered a new vehicle.
- o December 17, 1975 — The NHTSA proposed establishing less stringent permanent stopping distances, brake retardation forces, and modified recovery and timing requirements. The proposed stopping distances required a loaded vehicle to stop in 293 feet from 60 mph on a dry surface.
- o January 6, 1976 — The NHTSA amended the standard by suspending the service brake stopping distance requirement for buses until January 1, 1977.
- o January 7, 1976 — The NHTSA proposed extending the exemption for agricultural commodity trailers from March 1, 1976, to June 30, 1976.
- o February 20, 1976 — The NHTSA amended the standard for agricultural commodity trailers as proposed on January 7, 1976.
- o February 26, 1976 — The NHTSA amended the standard as proposed on December 17, 1975. This amendment was published on March 1, 1976, and became known as "Notice 7." The preamble of the Notice presented a condensed history of the standard and referenced numerous research documents and publications in support of the various aspects of the regulation. The amendment resulted from the NPRM, comments made at the October 29-31, 1975, public meeting, field experience information collected by the NHTSA, and petitions from Freightliner Corporation, Paccar Corporation, White Motor Corporation, and the ATA. This amendment established a 293-foot stopping distance from 60 mph on dry pavement.

#### October 29-31, 1975, Public Meeting

A public meeting on FMVSS 121 was held on October 29, 30, and 31, 1975, in Washington, D.C. The Administrator of the NHTSA chaired the majority of the meeting. The meeting covered the history of the implementation of FMVSS 121 and the experiences of manufacturers and users of FMVSS 121-equipped vehicles. Representatives of 37 organizations made statements at the meeting.

This meeting has been described by the NHTSA staff as significant because it focused on the most recent problems with FMVSS 121 and provided the NHTSA with a consolidated record upon which it could base modifications of the

standard. Statements from many of the parties affected by the standard covered the following topics:

- o The costs of complying with the standard.
- o The technical problems experienced with antilock devices, especially the Rockwell system on buses.
- o Rockwell's assessment of when the problems with their system could be corrected.
- o The effects of radio frequency interference.
- o The torque requirements for front axles and suggested revisions.
- o Accident rates before and after implementation of the standard.
- o Recall campaigns on FMVSS 121 systems.
- o Maintenance aspects of brake systems.
- o The economic impact of the standard.

Throughout the discussions commenters with opposing points of view on each issue were invited to question those making statements. At the end of the meeting the NHTSA commented that the record of the meeting would be reviewed by the agency and appropriate revisions of the standard would be proposed in the near future.

Paccar, Inc. (et al.) vs. the NHTSA

On January 3, 1975, Paccar, Inc.<sup>20/</sup> filed a petition for review of FMVSS 121 with the United States Court of Appeals for the Ninth Circuit. The petition requested that the court set aside all portions of FMVSS 121. Additionally, on January 17, 1975, Paccar, Inc. petitioned the court to suspend, or stay, the enforcement of FMVSS 121 pending review of the issue. On February 10, 1975, the court denied the motion for a stay of the standard and agreed to review the case.

Similar court petitions were filed by the Truck Equipment & Body Distributors Association (TEBDA) and ATA. The three review proceedings were consolidated into one case before the Court of Appeals for the Ninth Circuit on October 15, 1975.

When the oral arguments were presented on January 16, 1976, the court announced that it was going to stay FMVSS 121 for a minimum of 60 days. The government appealed to the Supreme Court to reverse that suspension and Supreme Court Justice Rehnquist did so on January 30, 1976.

The April 29, 1976, "Order Setting the Record and the Issues" filed before the court listed the following issues:

<sup>20/</sup>Paccar, Inc. is a holding company for two vehicle manufacturers, Peterbilt and Kenworth.

1. Whether in promulgating MVSS 121 NHTSA complied with its statutory duty to consider relevant available motor vehicle safety data, including the results of research, development, testing and evaluation activities (15 U.S.C. 1392(f)(1)).
2. Whether MVSS 121 fulfills the statutory requirement of meeting the need for motor vehicle safety (15 U.S.C 1392(a)).
3. Whether MVSS 121 establishes performance, rather than design, requirements.
4. Whether MVSS 121 fulfills the statutory requirement of practicability (15 U.S.C 1392(a)).
5. Whether MVSS 121 fulfills the statutory requirement of being stated in objective terms (id.).
6. Whether the NHTSA's promulgation of MVSS 121 was arbitrary, capricious, or an abuse of discretion.

Listed under the section, "Admitted Facts," the following were some of the facts not contested by any of the parties involved in the case:

- o Except for testing described in the Murphy Report<sup>21/</sup> the NHTSA did not conduct any reliability testing of vehicles with SS-121 components prior to the effective dates of SS-121.
- o There have been 9 safety-related defect reports made to the NHTSA involving antilock systems.
- o There are vehicles, not equipped with SS-121 equipment, which can meet the stopping distance requirements of SS-121.
- o Load proportioning devices do not eliminate all lockup of wheels under all circumstances.
- o The practicableness requirement of the Safety Act includes economic reasonableness.
- o The NHTSA has not yet begun testing of vehicles for compliance with SS-121.

Paccar and ATA contended that the following additional issues applied:

1. Whether the NHTSA has a statutory duty to collect data to determine whether pre SS-121 airbrakes are unsafe; whether the NHTSA has fulfilled such duty; and if the NHTSA has not fulfilled such a duty whether SS-121 is invalidated for that reason.

<sup>21/</sup> R.W. Murphey, et.al., "bus, Truck...." op. cit.

2. Whether the NHTSA has a statutory duty to conduct research, development and testing to insure that brake systems required by SS-121 are reliable and safe; whether the NHTSA has fulfilled such a duty; and if the NHTSA has not fulfilled such a duty whether SS-121 is invalid for that reason.

Highway Safety Research Institute  
Fleet Accident Evaluation of FMVSS 121

In late 1975, the Highway Safety Research Institute (HSRI) of the University of Michigan began an NHTSA-sponsored, 30-month contract to evaluate the safety impact of FMVSS 121. The main objective of the study was to collect exposure data such as the total mileage and accident data for trucks manufactured before and after the standard became effective. A secondary objective was to compare the maintenance and operational experiences of the pre- and poststandard vehicles.

Data were obtained from three sources:

- 1) The records maintained by a nationally representative sample of vehicle owners and operators.
- 2) BMCS accident data submitted by motor carriers who had operating authority from the Interstate Commerce Commission.
- 3) The NHTSA Fatal Accident Reporting System (FARS) supplemented by data from telephone interviews.

The sample covered small, medium, and large for-hire and private fleets and a variety of vehicles including straight trucks, tractors, and school buses. The sample was split between prestandard vehicles (1,492 vehicles) and poststandard vehicles (1,685 vehicles). To account for any bias that might be introduced by vehicle age, the prestandard vehicles were restricted to 1974 model (or newer) vehicles. Quarterly visits to each fleet were made to collect data on mileage readings, brake system maintenance, and accidents.

1976 House Subcommittee Hearings on FMVSS 121

In March 1976, the Subcommittee on Consumer Protection and Finance of the House Committee on Interstate and Foreign Commerce conducted 2 days of hearings on FMVSS 121. At these hearings antilock manufacturers reported that their warranty experience with antilock systems was extremely satisfactory and the International Brotherhood of Teamsters gave its endorsement of the standard.

In its official oversight report the House Committee indicated its approval of FMVSS 121 and observed that the "lengthy rulemaking process for this standard provided manufacturers, users, and the public ample opportunity to express views to the agency which, in turn, made considerable efforts to accommodate the manufacturers' difficulties during the production process." The Committee found that "the start-up problems" common to every new standard "have been largely resolved," and that the "basic objections to Standard 121, cost and reliability, appear to have been worked out, particularly in view of the latest amendment to the standard, effective on February 26, 1976." The Committee concluded that "Standard 121 should remain unchanged in order to reduce the human and economic losses resulting from the hundreds of thousands of accidents involving air braked motor vehicles which occur each year."

#### NHTSA Extensions of Exemptions to the Standard

On May 13, 1976, the NHTSA proposed to extend the temporary suspension of service brake stopping distance requirements for buses from January 1, 1977, to September 1, 1977. The NHTSA restated that it would continue to monitor field evaluations of antilock devices and indicated that production plans of Rockwell and Motor Coach Industries had been reviewed. The NHTSA also stated that there were current investigation programs by the industry underway and that there was insufficient time to collect and analyze data before January 1, 1977. The comment period closed on July 1, 1976.

On June 23, 1976, the NHTSA issued an amendment adopting the proposed definitions of when a rebuilt trailer is considered to be a new vehicle.

On June 30, 1976, the NHTSA issued an NPRM to extend the exemption from brake requirements for agricultural commodity trailers until June 30, 1977. The NPRM was in response to a petition from Titan Trailers Corporation and contained a statement that the proposal would cause no adverse safety or economic impact. The comment period closed on August 20, 1976.

Also on June 30, 1976, the NHTSA republished FMVSS 121 in its entirety "because the number and complexity of recent amendments to [FMVSS 121] may have created confusion for some interested persons."

On September 22, 1976, the NHTSA amended the standard by adopting the extension for agricultural commodity trailers proposed on June 30, 1976.

On September 23, 1976, the NHTSA issued a Notice of Interpretation of the "no wheel lockup" requirements on tandem axles. The Notice referred to test data received from manufacturers indicating that one control module on a tandem axle would produce the same performances as individual modules for each axle. The interpretation left the number of sensors and control modules up to the manufacturer and allowed the current process of placing sensors only on that axle which would lock up first.

On November 19, 1976, the NHTSA amended the standard by extending the existing service brake stopping distance requirement for buses from January 1, 1977, to September 1, 1977.

#### NHTSA Testing of FMVSS 121 Vehicles

The NHTSA in response to questions raised about the standard, initiated a testing program at the NHTSA Safety Research Laboratory. The testing was conducted between June and December of 1975 and reported in August 1976.<sup>22/</sup> Three tractors and three trailers were tested to the vehicle test procedures in FMVSS 121; additional related straight-line braking maneuvers were also included. Two of the tractors and two trailers were equipped with production braking systems designed to comply with FMVSS 121. The other tractor and trailer were equipped with pre-FMVSS 121 braking systems.

<sup>22/</sup> "Air Braked Vehicle Performance: FMVSS No. 121 Braking Systems versus Pre-FMVSS No. 121 Braking Systems & Stability Augmentation Devices," NHTSA Safety Research Laboratory, August 1976.

Tests were also conducted to simulate emergency maneuvers and evaluate the use of three stability augmentation devices, including the Breeze Corporations, Inc., anti-jackknifing device. In this portion of the program, four tractor-trailer combination vehicles were tested in eight different maneuvers designed to simulate on-highway emergency situations. The performance of vehicles equipped with FMVSS 121 braking systems was compared to that of vehicles with pre-FMVSS 121 braking systems. In addition, the use of stability augmentation devices was evaluated.

The conclusion of the test results was stated as follows:

For the conditions evaluated, data indicated that the FMVSS No. 121 systems provided superior braking performance to pre-FMVSS No. 121 systems and in addition that the use of the three stability augmentation devices evaluated would not upgrade pre-FMVSS No. 121 system performance to that of a FMVSS No. 121 system.

#### NTSB Highway Accident Report - Seattle, Washington

On December 4, 1975, an FMVSS 121-equipped tank truck pulling a pre-FMVSS 121 full trailer crashed in Seattle, Washington. The Safety Board investigated the accident <sup>23/</sup> and found that the truck's brakes were more effective than the trailer's and that the truck's wheels had not locked while the trailer's had. This situation, while not directly causing the accident, led to the trailer pushing the rear of the truck which contributed to the jackknifing of the vehicle. The Safety Board also stated that the NHTSA "...tests of FMVSS-121 antilock brake systems have been limited. Tests were not extended to include the type of combination vehicle involved in the Seattle, Washington, accident, nor to all of the possible combinations of vehicles and brake systems that currently are operated on the Nation's highways." On September 24, 1976, the Safety Board recommended that the NHTSA:

Test and resolve the apparent problem of operating any vehicle combination over the full-speed range and road and weather conditions encountered in normal operations if one of the units is equipped with [FMVSS 121] antilock brake system and the other unit is not.

#### Transportation Research and Marketing Studies

During 1976 and 1977, the NHTSA sponsored two studies to evaluate FMVSS 121. In December 1976, the final report of the first study, performed by Transportation Research and Marketing (TRAM) of Salt Lake City, Utah, was submitted. This study was designed to "...evaluate the experience of the fleets who acquired the new 121-equipped tractors and trailers during the past eighteen months." The study consisted of interviews and data requests from 60 fleets throughout the country, predominantly selected as "fleets being the safest in the land..." The final report indicated that fleets were experiencing problems with the new systems in four general areas: Wiring, sensors, valves, and brake balance.

<sup>23/</sup> "Highway Accident Report: Union Oil Company of California, Tank Truck and Full Trailer Overturn and Fire, Seattle, Washington, December 4, 1975." (NTSB-HAR-76-7)

It also noted that some fleets were disconnecting the antilock systems. The report contained the following recommendations:

1. Put a moratorium on all installations of 121 systems on trailing units.
2. Require antiskid systems on the power axle of the tractor only, but at the same time require the performance certification of the pneumatic system before any further units can be built with antiskid systems on them.
3. Require procedures for balancing tractors to all trailers before certifying production of further antiskid equipped units.
4. Establish a national data hot line to develop a source of communications between users and knowledgeable staffs who can help clean up the present problems.
5. Structure a permanent brake committee of industry personnel to work with DOT to implement brake improvements as fast as possible.
6. Do not lift the moratorium on 121-equipped trailers until the majority of tractors in service are equipped with antiskid systems on the drive axles and are designed to balance the total braking system.

On July 31, 1977, TRAM submitted a second report, requested by the NHTSA, entitled, "A Case Study Report on Fourteen Fleets - FMVSS 121." The stated objective of the study was:

to survey twelve of the fleets included in the HSRI study<sup>24/</sup> to determine the answers to three questions: (1) What proportion of units equipped with 121 systems are running with the system disconnected or inoperative? and, to extent possible, Why?; (2) What is the accident rate of poststandard vehicles as compared to prestandard vehicles?; and (3) What information concerning operational status, or problems associated with 121 braking systems is not getting recorded in fleet maintenance records and/or is not being picked up by the University of Michigan? Why?

The report did not specifically fulfill the stated objective but rather recounted the experiences of the 14 fleets in a narrative format. The findings stated that all but four of the fleet operators found "...absolutely no discernible difference in accident characteristics of prestandard and poststandard equipment."

24/ Fleet Accident Evaluation of FMVSS 121.

There was "no consistent pattern for adjusting warranty data to cover the start-up period of FMVSS 121. . . "; "All fourteen fleets indicate an absence of disconnects; however, two of the three fleets where equipment was inspected had lights taped over in the tractor"; and that, "there is evidence of difficulty in getting adequate service on 121 brakes in the field. . . ."

The report concluded that "the indications are that tractor systems are getting better. Driver interviews show an increasing acceptance and reliance on 121 tractor systems. Trailer brakes are not getting better."

#### Compliance Testing of the Standard

In late 1975, the NHTSA awarded a contract to Automotive Research Associates of San Antonio, Texas, to develop the procedures for compliance testing of the standard. Actual compliance testing began in December 1976. This was consistent with the stated philosophy of the NHTSA of not starting compliance testing until all of the startup problems of these systems had been resolved. Along those lines, the detailed laboratory procedures were not developed until the standard had been finalized. These procedures, as developed by Automotive Research Associates, supplemented the procedures for testing contained in the body of the standard.

#### NHTSA Exemptions from the Standard

On May 10, 1977, the NHTSA issued a Notice of Clarification concerning the replacement of brake components. The NHTSA stated that the Notice 7 level of performance represented the ". . . agency's view of the appropriate level of protection that should be provided . . ." and that a commercial facility that "substituted components to meet that requirement, in place of ones designed to meet the prior requirements, would not be in violation of the law."

On May 20, 1977, the NHTSA proposed to extend indefinitely the exemption for agricultural commodity trailers. The NPRM was in response to petitions for extension of the temporary optional requirements which were in effect until June 30, 1977. The comment period closed on June 20, 1977.

On June 7, 1977, the NHTSA amended the standard in response to petitions for reconsideration. The amendment extended the existing suspension of the bus service brake stopping distance requirements for 4 months and extended it 7 months for schoolbuses. The effective dates were January 1, 1978, for transit and intercity buses and April 1, 1978, for schoolbuses.

On June 9, 1977, the NHTSA proposed to add vehicles to the category of oversized and specialized vehicles exempted from the standard; to extend the temporary exclusion of heavy hauler and auto transporter trailers until January 1, 1979; and to eliminate the "no wheel-lockup" requirement for specified trailers. The comment period closed on July 11, 1977.

On June 27, 1977, the NHTSA amended the standard by extending indefinitely the exemption for agricultural commodity trailers.

On August 16, 1977, the NHTSA further amended the standard adopting the exemptions and extensions proposed in the Notice issued on June 9, 1977.

### Truck and Bus Safety Subcommittees' Recommendations

In 1977 the Truck and Bus Safety Subcommittees of both the National Highway Safety Advisory Committee and the National Motor Vehicle Safety Advisory Council prepared a series of recommendations to the Secretary of Transportation concerning FMVSS 121. Specifically, on March 24, 1977, the subcommittees recommended that FMVSS 121 requirements remain in effect and that BMCS should require carriers, effective January 1, 1978, to increase preventive maintenance on these systems. They stated that, ". . . the subcommittees believe FMVSS 121 offers outstanding vehicle handling and braking safety concepts which should not be abandoned at this time." The subcommittees also recommended a continuation of the exemption of buses from service brake stopping distance requirements until January 1, 1979.

On September 20, 1977, the subcommittees adopted a resolution for deferral of the "no wheel-lockup" provisions of the standard until antilock devices were proven successful through further development and testing. The resolution called for the NHTSA and the trucking industry to cooperate in testing the systems on large and small fleets.

On September 22, 1977, a mail ballot was sent to the subcommittee members which resulted in setting aside the resolution of September 20, 1977. The mail ballot referred to "potential disruption" that implementation of the resolution would create. The subcommittees resolved to establish an ad hoc committee to present to the subcommittees a full range of alternatives concerning the antilock provisions of FMVSS 121.

### HSRI Preliminary Findings - October 1977

In October 1977, the NHTSA published an interim report of the HSRI contract study, "Fleet Accident Evaluation of FMVSS 121" which covered the first half of the study period, calendar year 1976. The preliminary results showed "a slightly lower rate of accident involvements, on a per mile basis, for the 121-equipped vehicles, along with substantially more frequent maintenance." <sup>25/</sup>

That report contained a caveat that the results were very preliminary in nature, that data were still being collected, and that no firm conclusions could be drawn from the findings. On the subject of exposure, the findings indicated a significant difference ". . . between the pre and poststandard vehicles in terms of owners, types of vehicles, and usage." This difference in the composition of fleets was considered important because it had a direct bearing on the comparison of accident rates of the different categories of vehicles.

<sup>25/</sup> Kenneth L. Campbell, "Preliminary Findings on the Fleet Accident Evaluation of Federal Safety Standard 121," HSRI Research Review, September-October, 1977.

The accident rate findings were based on 268 accidents, of which only 84 involved straight trucks or schoolbuses. The results indicated that tractor accidents decreased 4 percent; straight truck accidents, 21 percent; and schoolbus accidents, 59 percent. The overall rate of accident involvement for poststandard vehicles decreased 19 percent. The report also stressed that it was just as likely that there were no actual differences in the accident rates of pre- and poststandard vehicles and that the findings were too preliminary to justify conclusions.

The study compared maintenance rates for pre- and poststandard vehicles. The findings suggested that the interval between required maintenance (vice preventive maintenance) generally decreased for poststandard vehicles. The report noted that the maintenance interval on antilock components was only about 20,000 miles.

The report also indicated that the study's fleet monitoring program was being expanded to include data collection on post-Notice 7 vehicles since "many of the criticisms of the early 121 vehicles were addressed with the Notice 7 modifications."

#### California Highway Patrol Study of 121-Equipped Vehicles

On October 28, 1977, the California Highway Patrol (CHP) released a "Study of 121-Equipped Vehicles." The study was based on a comparative analysis of vehicle inspection forms for 1,000 combination vehicles in which at least one vehicle was equipped with FMVSS 121 brakes, and 433 pre-FMVSS 121 combination vehicle inspection forms which were selected randomly. The inspections of the FMVSS 121 vehicles had been performed between July 1, 1977, and August 31, 1977. The inspection reports were separated into three categories (pre-FMVSS 121 combination, intermixed combination, and post-FMVSS 121 combination). The CHP compared the vehicle defects which had been reported. The comparison showed that:

- 1) Pre-FMVSS 121 vehicles had higher percentages of defects in such areas as leaks, defective valves, and "other" brake deficiencies such as oil on brake linings. The CHP believed that these higher percentages were caused by the age of the vehicles.
- 2) Post-FMVSS 121 vehicles had a higher percentage of defects. CHP believed that this finding was related to the fact that FMVSS 121 required more equipment components than were previously required.
- 3) The intermixed combinations had a very high percentage (22 percent) of vehicles with brakes so far out of adjustment that they were unfit for highway operation. In comparison, 9 percent of the pre-FMVSS 121 vehicles and 17 percent of the FMVSS 121 vehicles were in this category. The CHP stated, "The 17 percent figure represents our future, since all vehicles in the future will be 121-equipped. . . ."

- 4) The study also stressed that the inspections included out-of-State vehicles, and therefore the results applied nationwide and not just to California.

#### NHTSA Task Force Evaluation of the Standard

In April 1977, the NHTSA formed a task force which issued a "Technical Assessment of FMVSS 121-Air Brake Systems." The task force had members from the NHTSA both those familiar with the development of FMVSS 121 and those who were not, and one representative of BMCS. The BMCS task force representative stated, however, that he was not included in the meetings of the task force and did not see the final report until after it had been released. The task force analyzed many reports on the effectiveness of FMVSS 121, visited fleets that complained about antilock or other parts of the standard, conducted 500 courtesy inspections of FMVSS 121-equipped vehicles along with BMCS personnel, reviewed accident reports, obtained and analyzed warranty data from manufacturers, and developed studies of driver and mechanic training.

The final report of the task force, issued on February 24, 1978, covered five broad topics: The safety impact of the standard, inoperable systems, reliability, defects, and the compatibility of pre- and poststandard vehicles.

During the safety impact evaluation, the following were considered:

- o The preliminary findings of the HSRI Fleet Accident Evaluation study.
- o A review of five mass data bases (FARS, BMCS, Texas, North Carolina, and New York) which indicated a lower proportion of jackknifing accidents for poststandard vehicles.
- o The results of the Burlington Fleet Services Study<sup>26/</sup> which showed a higher accident rate for pre-FMVSS 121 vehicles.
- o The findings of the CHP Report on the Analysis of BMCS data. The task force differed with the report.
- o Telephone contacts and visits with some insurance companies. These indicated no known accidents directly associated with antilock devices.
- o A complaint by Wilson Freight Company about a dramatic increase in accident rates for their FMVSS 121-equipped tractors. The task force analysis concluded that the accident rates over the previous 17 months were virtually identical to those for the pre-FMVSS 121 vehicles and that any differences between the rates were not "large enough to be statistically significant."
- o A report by T.I.M.E. - D.C. that reported "significant reductions of accidents" for vehicles equipped to meet FMVSS 121.

<sup>26/</sup> This NHTSA-funded contract compared maintenance costs and accident data for fleets throughout the United States.

- o TRAM Surveys.
- o An ATA survey conducted in September and October, 1977. The task force concluded that it was a nonrepresentative survey to gather data concerning operating, maintenance, reliability, and repair experiences with antilock devices. No statistical accident data were included in the survey.
- o The task force determined that a Private Truck Council of America, Inc. Survey had not provided sufficient data to support any conclusions.
- o An NHTSA - BMCS Driver Survey. Based on 500 truck inspections and interviews, the task force reported that 100 drivers stated that they believed that antilock brakes had saved them from an accident; whereas only 2 drivers believed antilock may have contributed in some way to an accident.

The task force report also stated that the NHTSA had acquired information on every accident in which an FMVSS 121 hardware failure or operating characteristic was alleged to have contributed to the accident. "To date, there have been no serious or fatal accidents which have factual supporting evidence indicating FMVSS 121 involvement." The task force had compiled summaries of 31 accidents for which FMVSS 121 had been alleged to be a causal factor. The summaries gave basic descriptions of the accidents, the allegations, and the findings of the investigations.

The task force report's analysis of the safety impact of FMVSS 121 stated:

There was a need for the standard when it was issued; there is still a need.

FMVSS 121 has resulted in an observed decrease in the accident rates for 121 vehicles as compared to the non-121 vehicles. We believe the HSRI study provides the best measure of this difference, but the observed 19 percent reduction in accident rates is not statistically significant.

Any improvement that is observed under-estimates the full potential effect of the standard, as large but unknown proportions of tractors and trailers (perhaps on the order of 40 percent and 65 percent) have the antilock portion of the 121 brakes inoperable.

We expect the standard to reduce the severity of accidents as well as to decrease the likelihood of an accident. With the limited amount of data available we cannot detect this effect, even though shorter stopping distances should be producing it. Unfortunately, it will probably take another year or two before the severity reducing effect of the standard can be measured.

With the exception of a report from Wilson Freight, we find no substantial body of data that indicates that 121 trucks are less safe than non-121 trucks.

The task force's evaluation of antilock systems which were inoperable was based on the joint NHTSA-BMCS inspections. The task force stated that:

- o 64 percent of the power units were definitely operable, 6 percent were definitely inoperable, and 30 percent were unknown.
- o 35 percent of the trailers were definitely operable, 45 percent were definitely inoperable, and 20 percent were unknown.

The task force based its evaluation of reliability on the available studies and surveys, and stated that antilock devices were becoming more reliable; the major components were already very reliable; and the weak points (wires and connectors) would only become more reliable if the requirement for such devices were perceived by the industry as being a long-term one.

The task force evaluated the defect campaigns for FMVSS 121 brake systems and the following summarization was contained in the report:

To date no truck or tractor-trailer accidents have been determined to have been caused by an antilock system defect. Early in the effective period of FMVSS No. 121 about twenty accidents involving buses were determined to have been caused by defective antilock systems. None of these was a serious accident.

\* \* \* \*

Antilock system defects are known to have resulted in about twenty minor accidents, all on buses in 1975.

The defects experience of antilock systems is not as serious as is often implied. Less than 4 percent of 121-equipped vehicles have been recalled for brake defects, as opposed to over 15 percent of the passenger cars built during the same period.

\* \* \* \*

Since the introduction of the standard, 28,878 121-equipped vehicles have been recalled for safety-related defects. Of those, 24,459 were for antilock systems defects. In addition, 118,313 equipment supplier components have been recalled.

The number of components actually defective is typically less than one fourth of those recalled.

The effectiveness of NHTSA's defect recall program for trucks depends on communications from drivers and fleet owners, as well as from manufacturers who are legally required to report known defects.

The task force report also contained an evaluation of testing done by the NHTSA Safety Research Laboratory concerning the compatibility of pre- and poststandard vehicles used in combination. The testing was done at the request of the Safety Board and other interested parties. Some of the conclusions listed by the task force were:

- (1) The most unstable of all combinations tested were those of an all pre-121 configuration with no front brakes on the tractor or truck. Such combinations are very prone to jackknifing.
- (2) The most stable combinations tested were those of the all FMVSS No. 121 configuration. In addition, these combinations stopped in significantly shorter distances than the all Pre-FMVSS No. 121 configurations.
- (3) Antilock installed on the front axles of FMVSS No. 121 tractors and trucks improves the overall control of the combination in panic (full treadle) applications since it prevents the front wheels from locking and allows the vehicle to be steered. In modulated brake applications, however, drivers found it relatively easy [to] keep the front wheels from locking when antilock was turned off.
- (4) With one exception, mixed combinations of FMVSS No. 121 and Pre-FMVSS No. 121 equipped vehicles out-performed all Pre-FMVSS No. 121 combinations in terms of stability and stopping distance. When operating with FMVSS No. 121 equipped power units the tendency to jackknife was reduced and with FMVSS No. 121 equipped trailers, trailer swing is minimized.

Public Meetings and Hearings on FMVSS 121-  
December 1977

On December 1, 1977, the NHTSA announced a public meeting for December 15, 1977, to discuss the safety and operational performance of trucks, buses, and trailers designed to meet the requirements of FMVSS 121. The NHTSA stated that the following major issues would be discussed:

- (1) Whether the anticipated benefits of antilock installation have materialized;
- (2) Whether the requirement for no lockup performance is resulting in safety-related defects and accidents because of the malfunction of antilock systems installed in compliance with the standard;
- (3) Whether some or all of the commercially available antilock designs require inordinate purchase and maintenance costs that make further installation unjustified, despite theoretical or actual benefits of no lockup performance;
- (4) Whether a reliable antilock system can be manufactured and maintained at a reasonable cost, and whether a motor vehicle safety standard can be written to require that type of performance;

(5) Whether truck operators have utilized their full resources and capabilities to properly effectuate the standard;

(6) Whether some manufacturers' antilock systems offer better reliability and durability than those of other manufacturers;

(7) Whether the Agency should take any action with regard to the no lockup provision of the standard based on experience with the standard to date;

(8) Whether special test program of conforming vehicles should be developed, with or without the involvement of the Department of Transportation, to provide additional data on antilock system operation.

On December 6 and 7, 1977, the Subcommittee on Governmental Efficiency and the District of Columbia of the Senate Committee on Governmental Affairs, held hearings on FMVSS 121. During these hearings the development of FMVSS 121 was reviewed, with particular attention given to the applicability of the standard to schoolbuses.

A former Administrator of the NHTSA, John Snow, recounted the efforts of the agency to evaluate the effectiveness of the standard from July 1976 to March 1977.

The NHTSA Administrator, Joan Claybrook, described the ongoing activities of the NHTSA to evaluate the standard (HSRI study); indicated that a task force was doing an internal evaluation of the technical issues of FMVSS 121; described the coordination efforts of the NHTSA and BMCS concerning the enforcement of the standard; and mentioned the scheduled December 15, 1977, public meeting. The Administrator indicated that many of the issues of FMVSS 121 were still unresolved such as schoolbuses, and that steps were being taken to resolve those issues as soon as practicable.

The Acting Chairman of the Safety Board, Kay Bailey, testified on past Safety Board positions on truck braking, the concerns about combination vehicle compatibility, and suggested the use of the General Services Administration to perform fleet testing of advanced safety equipment.

Testimony was also presented by Transportation Research and Marketing, American Public Transit Association, California Highway Patrol, International Brotherhood of Teamsters, United Parcel Service, American Trucking Associations, Inc., Wilson Freight Co., Consolidated Freightways, Roadway Express, Private Truck Council of America, General Motors Corp., Eaton Corp., B.F. Goodrich, Berg Manufacturing Corp., Bendix Corp., Wagner Electric Corp., Breeze Corporations, Professional Drivers Council on Safety and Health, and the National School Transportation Association.

The subcommittee made the following recommendations to the Secretary of Transportation:

- o Regarding school uses:
  - "1. Continue the exemption for school buses.
  - "2. Undertake thorough, supervised, on the road tests of 121 equipment in trucks before reimposing the standard."
- o Consider exempting trailers from the "no lockup" provisions of the Standard.
- o Beyond the immediate questions about the safety of 121 computers and their application to buses is concern over the governmental process by which safety standards are adopted and administered. The subcommittee believes that before any new standard is promulgated by NHTSA, there should be agreement within DOT that it will be enforced. NHTSA and BMCS appear now to be working together on 121, it is foolish government to permit agencies independently to carry on contrary policies. In the case of 121, the lack of enforcement by BMCS was interpreted by many trucking companies as implicit confirmation of the contention that the computers were impractical and difficult to maintain and should be disconnected.

Administrative action should be taken within DOT to assure coordination and concerted action on standards that are promulgated. Additionally, DOT should undertake to establish its own testing facilities to assure the data independent of manufacturers' certification is available before a decision is made to mandate particular equipment for use on the nation's highways.

Laboratory, test track and actual day-by-day experience should be combined much the way the government already does in the field of aviation. Certainly, it seems conclusive, safety equipment is not mandated for airplanes unless thoroughly tested and proven in laboratory and in actual flight conditions.

These are the major lessons to be derived from the 121 controversy, and the subcommittee earnestly believes DOT should take action to implement them.

On December 15, 1977, the NHTSA held a public meeting in Washington, D.C., to review the issues of FMVSS 121. Truck manufacturers reported that the antilock devices cost them from \$120 to \$180 per axle. Truck operators reported costs of \$460 for a two-axle tractor and \$695 for a three-axle tractor. Truck manufacturers indicated that warranty costs for maintaining the systems were significantly higher during the startup phase of the standard's implementation but that the costs were generally leveling out.

The HSRI presented preliminary findings that brake system maintenance was required 30 percent more frequently on tractors but that antilock components did not contribute heavily to that figure. Both HSRI and Burlington Fleet Service reported decreased accident rates for the FMVSS 121-equipped vehicles. However, the data could not explain why the rates appeared to be lower. Conflicting reports were made by truck operators relating to their accident experiences with pre- and poststandard vehicles. Defect histories of truck operators, antilock manufacturers,

and truck manufacturers were presented and compared.

The following recommendations were made:

- o The ATA recommended that the NHTSA: (1) Remove the "no wheel-lock up" provision of the standard; (2) convene a knowledgeable technical group composed of vehicle manufacturers, users, and the NHTSA to work out the details of a large cooperative test program to fully evaluate the benefits, fail-safe characteristics, reliability, and problems of the antilock system; (3) utilize the expertise of the same technical group to establish a means of providing information for users experiencing FMVSS 121 problems of all types, provide guidance to the NHTSA in the revision of other problem areas of the standard, and provide guidance to the NHTSA in the formulation of any future brake standards; (4) upon completion of a successful test program and a confidence level of antilock reliability, phase antilock back into the standard starting with the rear drive axles of trucks and tractors.
- o International Harvester strongly urged that the "no lockup" requirement be revoked. Ford saw no strong evidence for the proposition that the standard is good or bad, and would therefore leave it as is. Ford believed that antilock can contribute to safe stopping of a vehicle with less reliance on driver skill. Ford believed it would be prudent to delay re-implementation of the "no lockup" provision for school buses, and a front wheel limiting valve should be reinstituted. General Motors requested continuation with no changes. White Motors preferred no changes.
- o APTA asked for a comprehensive test program before the requirements were reimplemented for transit buses.
- o Wagner Electric Corporation advocated retention of the "no wheel lockup" requirement. Bendix also suggested retention, without extending the requirements to any new vehicle classes. B.F. Goodrich, Berg, and Kelsey-Hayes also advocated retention of the standard in its present form.

#### NHTSA Notices to Modify the Standard

On December 14, 1977, the NHTSA issued a Notice of Interpretation of the requirement that an air reservoir "withstand" specified pressures. The NHTSA gave a technical interpretation of the meaning of the word "withstand" as it was used in the standard.

On December 30, 1977, the NHTSA denied petitions from the American Public Transit Association, American Bus Association, Greyhound Corp., Trailways, Inc., and Motor Coach Industries to extend the stopping distance suspension for buses. The NHTSA stated that reliable antilock devices were available and that "...most bus manufacturers have determined that the 'no lockup' portion of the requirement can be met without the use of antilock systems."

On February 23, 1978, the NHTSA withdrew its interpretation of December 14, 1977, noting that the interpretation inadvertently had resulted in more stringent requirements.

On March 8, 1978, the NHTSA proposed suspension of the "no wheel-lockup" requirement of the standard for trailers. The Notice solicited comments regarding a demonstration program to quantify maintenance and other difficulties with trailer systems, and announced a public meeting for April 24, 1978.

Also on March 8, 1978, BMCS issued an NPRM proposing revision of its regulations to require that any antilock system installed on the drive axle of truck tractors to comply with FMVSS 121 be kept operative by motor carriers.

On March 20, 1978, the NHTSA amended the standard by suspending indefinitely the service brake stopping distance requirements for schoolbuses. The action was taken "... to preserve the status quo of the standard's applicability while more far-reaching issues of the air brake standard are resolved by the Department."

#### Court Actions

On April 17, 1978, the U.S. Court of Appeals for the Ninth Circuit announced its judgment on the Paccar, Inc., case. The court ruled that the record demonstrated a "need" for the standard as specified under the Safety Act of 1966 because reducing stopping distances and improving handling during stops were related to the goal of improving highway safety. However, the court ruled that the required stopping distance was neither reasonable nor practicable at the time it was put into effect. The court found that there was a strong probability that antilock devices would not work well and that the NHTSA had the responsibility to assure that those systems were reliable when placed in use. The court ruled that the NHTSA had not satisfied that duty. In light of those considerations, the court ruled that the stopping distance requirement from 60 mph was not practicable and therefore the NHTSA was not allowed to enforce it.

The court also ruled that the NHTSA had not been objective nor practicable in establishing the compliance testing procedures. The court ruled that those requirements were not economically feasible for intermediate and final stage manufacturers and that the specification of skid numbers for test surfaces was not practicable. The NHTSA was therefore ordered not to enforce those portions of the standard until they were clarified.

The court rulings were limited to trucks and trailers, since the issue of buses had not been appealed.

On April 20, 1978, the NHTSA canceled the public meeting scheduled for April 24, 1978. On June 2, 1978, the NHTSA extended indefinitely the comment period for the NPRM to suspend the "no wheel-lockup" requirement for trailers. On June 5, 1978, BMCS extended indefinitely the comment period on its proposal to require carriers to keep antilock systems operative.

In July 1978, the NHTSA petitioned the U.S. Supreme Court to review two of

the three rulings of the Ninth Circuit Court. The NHTSA appealed the findings that antilock devices had not been shown to be reliable and that the combination of "strong front axles, new brake linings, and mini-computers" had not been shown to increase safety.

On August 25, 1978, the NHTSA amended the standard to fulfill the third finding of the Ninth Circuit Court of Appeals. The amendment specified test procedures and conditions for frictional characteristics of the test track surface, duration of time intervals between road tests, duration of permissible wheel lockup during road tests, and the amount of curving in the test track.

On September 6, 1978, the NHTSA issued an NPRM proposing amendments to "broaden and simplify the parking and emergency brake performance requirements, and to temporarily extend exclusions for heavy hauler and auto transporter vehicles from aspects of the standard that are the subject of judicial review." The Notice stated that "... the exclusions would preserve the status quo for affected vehicles regarding those portions of the standard subject to judicial review."

On October 2, 1978, the U.S. Supreme Court declined to hear the NHTSA appeal and mandated the effectiveness of the Ninth Circuit Court of Appeals decision on October 11, 1978.

On October 13, 1978, the NHTSA issued a Notice setting forth the NHTSA interpretation of the court decision. The NHTSA stated that the "no wheel-lockup" portions of the standard as they applied to trucks and trailers were invalid, along with the related stopping distances for trucks from 60 mph (or the highest speed attainable by the vehicle). The agency also specified an alternate means of certifying compliance for intermediate and final stage manufacturers.

On October 16, 17, and 18, 1978, the NHTSA held informal meetings with manufacturers and users of components and vehicles affected by the standard. The NHTSA advised these parties of the NHTSA interpretations and requested comments from companies who felt the interpretation was not satisfactory. The NHTSA stressed that stops within the specified distances from 20 mph were still required and that if manufacturers had difficulty meeting those requirements without antilock devices they should petition the NHTSA.

The NHTSA also announced that it would publish a Notice requesting comments on what future actions the NHTSA should take in the area of braking. The NHTSA took that opportunity to announce preliminary data from the HSRI Fleet Accident Evaluation of FMVSS 121.

On November 28, 1978, the Chief Counsel of the NHTSA sent a letter<sup>27/</sup> to a manufacturer on how the court rulings affected existing vehicles. The NHTSA position was that the "no wheel-lockup" provision of the standard was invalid from the day the standard was implemented and therefore a commercial facility would not be in violation of the Safety Act of 1966 if it disconnected an antilock device. The NHTSA cautioned operators to check with manufacturers to determine the safest way to disconnect devices and stated that if an antilock device performed in an unsafe manner it could still be the subject of a safety defect action.

<sup>27/</sup> Letter, Joseph J. Levin, Jr. to Mr. J.K. Novell of Alloy Trailers, Inc., dated November 28, 1978.

On October 31, 1978, the Subcommittee on Governmental Efficiency and the District of Columbia of the Senate Committee on Governmental Affairs held a hearing on FMVSS 121. The hearing was held to determine the NHTSA plans since the U.S. Supreme Court action and, in particular, the NHTSA plans concerning buses. The NHTSA presented the preliminary findings of the HSRI Evaluation and indicated that a more comprehensive interim report had just been received on October 30, 1978. The NHTSA stated that that report had not been fully reviewed at that time.

However, the HSRI project officer for the Fleet Evaluation Contract testified before the Subcommittee. He indicated that the preliminary data showed no safety benefit attributable to FMVSS 121. He stated that there was a possibility that a tractor-trailer, equipped to meet FMVSS 121, when compared to pre-FMVSS 121 tractor-trailers, could have 70 percent and 90 percent higher accident rates for injuries and fatalities, respectively. He stressed that no statistical levels of confidence had been established yet and that the cause of accidents had not been determined.

On December 11, 1978, the NHTSA issued an amendment withdrawing those test condition changes issued on August 25, 1978. Those changes had been issued without opportunity for public comments because the NHTSA had ruled that they were required by the court mandate. In response to petitions for reconsideration, the NHTSA withdrew those prior amendments.

On January 16, 1979, the BMCS issued a Notice terminating its proposed rulemaking concerning antilock devices on drive axles of power units.

#### Advanced Notice of Proposed Rule Making for FMVSS 130

On February 12, 1979, the NHTSA issued an ANPRM on a new Air Brake Standard 130, for trucks, buses, and trailers, to replace FMVSS 121. The NHTSA stated that a separate ANPRM would be issued to "... address longer-range issues of braking technology such as automatic brake adjusters, and other means to improve vehicle stability, including antilock systems." In this ANPRM, the NHTSA solicited information on any suspected defects in past FMVSS 121 designs which might require recalls; recommendations for changes to the remaining requirements of FMVSS 121; information on models for which manufacturers plan to offer antilock devices as standard equipment; views on the consolidation of gains in truck and trailer braking over the past 8 years; data on the stopping capability of vehicles from 60 mph; and views on whether or not any new requirements should apply to schoolbuses.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING  
Chairman

/s/ FRANCIS H. McADAMS  
Member

/s/ PATRICIA A. GOLDMAN  
Member

/s/ G.H. PATRICK BURSLEY  
Member

ELWOOD T. DRIVER, Vice Chairman, did not participate.

August 2, 1979

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DATE  
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